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Final Report

EVALUATION OF TREATMENT ALTERNATIVES FOR STORMWATER IN PONDS A-4, B-5, AND C-2

Prepared for

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1.0 INTRODUCTION AND SUMMARY

This report provides an evaluation of treatment alternatives for stormwater discharge from Ponds A-4, B-5 and C-2 Treatment systems are required to assure compliance with the discharge criteria imposed by the Colorado Department of Health (CDH) These systems will replace the temporary systems presently being used for treatment of discharges from Ponds A-4, B-5 and C-2

IT Corporation (IT) was retained by EG&G Rocky Flats, Inc to perform the treatment system evaluation at the Rocky Flats Plant (RFP) This is the third and final report submitted by IT during the course of this work The first report was submitted in July, 1990 That report provided details on the design basis to be used to compare alternatives and an overview of the types of treatment technologies that were to be evaluated The second report was submitted in August, 1990 and provided process flow diagrams for the treatment alternatives showing how treatment technologies are integrated in the alternatives This final report provides an evaluation of the alternatives, recommendations of the alternatives that are best able to meet the design criteria for the least cost, and recommendations on pilot testing that should be conducted to confirm the treatment efficiencies presented in this report This report includes all alternatives defined in the second report along with two new alternatives added after the submission of the second report

1 1 SUMMARY OF RECOMMENDATIONS FOR ALTERNATIVES TO BE USED

A total of twelve alternatives were evaluated with regard to performance, costs and waste generation. Of these twelve, six utilize ultrafiltration (UF) as a final polishing step for the removal of uranium The six UF alternatives were evaluated during the preparation of this report and were found to be identical to the alternatives using ion exchange, except for the final unit operation In order to simplify the overall evaluation, a separate comparison was made between UF and ion exchange During this comparison, ion exchange was selected over UF for the following reasons

- UF generates a brine stream consisting of up to 20% of the stream being treated The brine would require further treatment or disposal

- There is a lack of existing facilities utilizing UF for the removal of uranium from an aqueous stream UF has not been proven to be an effective treatment method on the scale required for the pond water treatment

- There are high capital and O&M costs associated with UF (relative to ion exchange - a standard uranium removal technology)

The remaining six alternatives condition the pond water by providing solids removal via technologies such as settling/clarification, dissolved air flotation and filtration. Conditioning is followed by carbon adsorption for removal of organic contaminants and ion exchange for uranium removal These remaining alternatives have no outstanding individual characteristics in the areas of performance, cost or waste generation to warrant selection or elimination at this stage All of the alternatives should meet the discharge standards for the radionuclides of concern as well as the organic chemicals of concern A list of the remaining six alternatives each with a brief description and the original alternative number follows.

Alternative 1	Conditioning by a parallel plate separator followed with polishing with sand filtration, carbon adsorption and ion exchange
Alternative 2	Conditioning identical to Alternative 1 Polishing with cartridge filtration, carbon adsorption and ion exchange
Alternative 5	Conditioning by sand filtration with the backwash of the sand filter being treated by a sludge thickener and filter press Polishing achieved with cartridge filtration, carbon adsorption and ion exchange
Alternative 7	Conditioning by dissolved air flotation followed with polishing by sand filtration, carbon adsorption and ion exchange
Alternative 8	Conditioning identical to Alternative 7 Polishing with cartridge filtration, carbon adsorption and ion exchange

Alternative 11 Conditioning by sand filtration with the backwash of the sand filter being treated by a dissolved air flotation unit and filter press Polishing achieved with cartridge filtration, carbon adsorption, and ion exchange

(Note Alternatives 3, 4, 6, 9, 10 and 12 utilized UF and are not to be considered in further evaluations)

Evaluating the remaining alternatives to select a preferred alternative is heavily dependent on further bench- and pilot-scale testing A summary of suggested tests is presented in Section 1 2

1 2 SUMMARY OF RECOMMENDATIONS FOR BENCH AND PILOT TESTING

Further bench-scale tests supplemented with pilot-scale tests are necessary to make a justifiable selection of a treatment alternative All of the recommended bench- and pilot-scale tests deal with the conditioning (suspended solids removal) of the pond water Conditioning is a critical element of the overall treatment system since the removal of the small quantities of radionuclides associated with particulates (plutonium and americium) requires the removal of a large amount of suspended solids

Bench tests are needed to determine the behavior of the suspended solids in the pond water after the addition of a coagulant and flocculant Prior bench tests (in the form of jar tests) have shown that the addition of coagulant at 60 ppm followed by the addition of a flocculant at 1 ppm allowed a large but light floc to form. Settling of the floc did not occur until clay was added. Further jar tests are needed to quantify the addition of clay required to achieve settling of the flocculated suspended solids

Pilot-scale tests should be conducted to evaluate the performance of the following technologies

- Solid/Liquid separation by a parallel plate ("Lamella" type) separator
- Solid/Liquid separation by dissolved air flotation
- Solid/Liquid separation by sand filtration (including backwash requirements)

These technologies are options for the primary solid/liquid separation unit operation needed in each alternative The pilot tests should be performed while simulating the conditions as represented in the process flow diagrams incorporating the above technologies

Discussions with vendors capable of providing pilot-scale equipment indicate a concern on their part over liabilities associated with contamination of rented equipment The most common concern is that rented equipment may remain on site for up to a year Thus, their equipment would be unavailable to other potential clients For this reason, purchasing of pilot scale equipment must be considered

Details on bench- and pilot-scale recommendations are included in Section 5 0 of this report

2.0 TREATMENT SYSTEM DESIGN BASIS

A treatment system design basis was established in the first phase of the evaluation of the treatment systems for Ponds A-4, B-5 and C-2 This was done in order to provide a basis on which to compare treatment alternatives The design basis provides contaminant removal to the established discharge criteria assuming the worst case scenario for influent characteristics Analyses conducted on samples of water drawn from Ponds A-4, B-5 and C-2 demonstrate that the water generally meets the discharge criteria established by CDH The design basis is therefore established to provide treatment during occasional excursions from the discharge criteria

Due to the locations and treatment needs of Ponds A-4, B-5 and C-2, two separate treatment systems will be installed One system, designed to meet the discharge requirements of Ponds A-4 and B-5, shall be sized at 1,500 gallons per minute in order to meet the specified treatment range of 1,000 to 1,500 gallons per minute The other system will be designed to meet the discharge requirements of Pond C-2 at 750 gallons per minute Under normal operations, C-2 water will be recycled If discharge is necessary, the C-2 discharge will be diverted from the Woman Creek Drainage to the Walnut Creek Drainage This section establishes the design basis for each treatment system, however, costs, material balances and PFDs were only obtained for the 1500 gpm system Both systems will have similar removal requirements for contaminants that might be present Therefore, the comparison of alternatives for the treatment of water for Pond C-2 is adequately addressed in the comparison of alternatives for treatment of water from Ponds A-4 and B-5

2 1 CHARACTERISTICS OF WATER TO BE TREATED (Ponds A-4, B-5, C-2)

The design basis used for existing radionuclide concentrations in each of the ponds are as listed in Table 2 1 These figures represent the maximum concentrations measured in each pond for the radionuclides of concern The maximum concentration is used to provide a conservative design basis The figures for gross alpha and gross beta contamination are derived from samples collected from April 11, 1990 to June 4, 1990 Those for plutonium,

TABLE 2.1

EXISTING RADIONUCLIDE CONCENTRATIONS

CONCENTRATION (pCi/l)

	Alpha	Beta	Plutonium-239	Americium-241	Uranium-234, 238
Pond A-4	7	9	091	045	11 20
Pond B-5	6	11	080	064	8 00
Pond C-2	8	10	103	070	5 85

Amencium and Uranium are the maximum concentrations recorded for the penod 1988 through 1990

The concentrations measured for gross alpha radiation are inconsistent with those measured for uranium Uranium is almost exclusively an alpha emitter, so the gross alpha concentration should be equal to or greater than the uranium concentration To account for this discrepancy, the gross alpha concentration was assumed to be equal to the uranium concentration of 11 2 pCi/liter

Table 2 2 lists the regulated organic compounds that have an established discharge standard Except for Atrazine and Simazine, organic chemical concentrations in samples taken from all of the ponds are at or less than minimum detection limits (MDL) for those chemicals listed in Table 2 2 Current data, based on samples taken from Ponds A-4, B-5 and C-2 on January 16 and 17, 1990, show concentrations for Atrazine and Simazine at levels greater than MDL The maximum concentrations detected for these two compounds are 11 ppb and 1 9 ppb, respectively

Table 2 3 summarizes the maximum measured concentrations for total suspended solids (TSS) and biochemical oxygen demand (BOD) as well as minimum and maximum values of pH for each of the ponds

2 2 REQUIRED OUTLET CONCENTRATIONS

The primary purpose of each of the treatment systems is to maintain radionuclides and organic chemicals at or below discharge standards The radionuclides of concern and their discharge standards are listed in Table 2 4 The discharge standards listed are those associated with the Walnut Creek Drainage, thus, standards for this drainage are applicable to all three ponds Discharge standards for organic chemicals are assumed to be the minimum detection limits listed in Table 2 2 The state has also imposed standards that are below the MDL's for many of the compounds On the direction of Steve Pettis of EG&G, the MDLs will be used as discharge standards, use of lower standards would not allow meaningful evaluation of the treatment systems

TABLE 2.2

ORGANIC CHEMICAL STANDARDS/MINIMUM DETECTION LIMITS

CHEMICAL	EFFLUENT MDL/STANDARD (ug/l)
Acrylonitrile	10
Aldrin	0 01
Atrazine (1)	0 5
Benzidine	10
Chlordane	0 05
Chloroform	0 5
Chloroethyl Ether (BIS)	6
DDT	0 06
Dichlorobenzidine	10
Dieldrin	0 01
Dioxin (2, 3, 7, 8 - TCDD)	0 01
Halomethanes	0 5
Heptachlor	0 01
Hexachloroethane	0 1
Hexachlorobenzene	0 1
Hexachlorobutadiene	0 1
Hexachlorocyclohexane, Alpha	0 01
Hexachlorocyclohexane, Beta	0 01
Hexachlorocyclohexane, Gamma (Lindane)	0 01
Hexachlorocyclohexane, Technical	0 1
Nitrosodibutylamine N	0 5
Nitrosodiethylamine N	0 5
Nitrosodimethylamine N	0 15
Nitrosodiphenylamine N	0 8
Nitrosopyrrolidine N	10
PCBs	0 1
Polynuclear Aromatic Hydrocarbons	0 1
Simazine (2)	0 5
Tetrachlorethane 1,1,2,2	0 5
Tetrachloroethylene	0 5
Trichloroethane 1,1,2	0 5
Trichlorophenol 2,4,6	0 5

(1) Existing concentrations are 11 ppb, 2 3 ppb and 0 7 ppb for Ponds A-4, B-5 and C-2, respectively

(2) Existing concentrations are 1 9 ppb, 1 2 ppb and nondetectable for Ponds A-4, B-5 and C-2, respectively

TABLE 2.3

EXISTING POND CONDITIONS-BIOCHEMICAL OXYGEN DEMAND, TOTAL SUSPENDED SOLIDS AND pH

	BOD (mg/l)	TSS (mg/l)	pH	
			Minimum	Maximum
Pond A-4	N/A	40	8 0	9 6
Pond B-5	21	95	8 1	9 8
Pond C-2	N/A	40	8 1	9 2

N/A = no measurement taken for these ponds BOD expected to be less than Pond B-5 since Ponds A-4 and C-2 do not receive sewage treatment plant discharge

TABLE 2.4

RADIONUCLIDE EFFLUENT STANDARDS

RADIONUCLIDE	STANDARD (pCi/l)
Plutonium	0.05
Americium	0.05
Tritium	500
Uranium	10
GROSS ALPHA AND BETA	
Alpha	11
Beta	19

The discharge standards and maximum influent criteria provided in this design basis do not provide an accurate reflection of the requirements for the removal of non-soluble radionuclides Based on Tables 2 1 and 2 4, it could be concluded that the treatment system should provide a removal of 52% of the plutonium and 28% of the americium on a bulk basis This is misleading since any plutonium or americium present in the water would be in the form of discrete particles The established discharge criteria requires that concentrations be held to below 0 05 pCi/liter A single particle of plutonium dioxide that is 0 45 microns in diameter in one liter of water would have an activity of 0 24 pCi/liter, which is above the discharge criteria for a one liter sample Therefore, if one particle of plutonium dioxide were present in a one liter sample taken for analysis, the measured concentration of plutonium could exceed the discharge criteria even though the overall concentration was below the criteria In order to minimize this possibility, the design basis is established to provide the maximum achievable removal of plutonium and americium

The concern over the particulate nature of plutonium and americium is based on literature data and past projects performed by IT In Ponds A-4, B-5 and C-2, plutonium and americium are assumed to be associated with particulate matter (including colloidal particulates) Particulate removal is therefore critical in order to achieve the discharge standards for these radionuclides The standard for total suspended solids (TSS) removal is therefore established to be the maximum achievable by proven technologies It is expected that the material generated during the removal of particulates will consist mostly of algae which, for handling and disposal purposes, shall be considered low-level waste due to the possible presence of radionuclides

2 3 RESIDUE DISPOSITION

It is assumed that any waste generated as a result of pond treatment must be handled as low-level waste Exceptions to this assumption (either more stringent or less stringent) cannot be determined at this time. The material balances show that in treating the pond water with the concentrations of radionuclides as noted in the design basis, the concentration of plutonium and americium in waste sludges produced is less than 100 nCi/g This meets the requirement of 10 CFR 61 that transuranics in low-level waste total less than 100 nCi/g Low-level waste can be accepted at the Nevada Test Site, Hanford and several licensed private facilities Waste sludges generated will also be within the Low Specific Activity (LSA) limits per 10 CFR 71 - Packaging and Transporting Radioactive Material All residue disposal costs were developed assuming that wastes generated go to Nevada and are packaged in Type A containers

2 4 OTHER CONSIDERATIONS

The treatment systems designed are to be considered permanent "all-weather" facilities These shall replace the existing systems currently being rented Year round operation will require enclosures and heating systems capable of preventing freezing of equipment in winter Utilities required for operation of any treatment, heating and miscellaneous support equipment shall be supplied at the pond locations by the Rocky Flats Plant It is assumed that power lines can be run from Indiana Avenue to supply electricity

3.0 SELECTION AND COMPARISON OF ALTERNATIVES

3 1 SELECTION OF ALTERNATIVES

The treatment technologies that were investigated can be divided into three groups (1) water conditioning technologies for removal of TSS, (2) organic removal technologies for removal of atrazine and simazine, and (3) dissolved radionuclide removal technologies -- specifically, dissolved uranium Table 3 1 gives a list of all technologies considered in the evaluation

Technologies associated with particulate removal include flocculation/coagulation, sludge dewatering and effluent polishing These are proven and accepted water treatment technologies The necessary equipment is readily available to handle the treatment capacity desired Pilot testing and the refining of available data are required to demonstrate that the effluent concentrations can be achieved and to determine the best combination of technologies/equipment for particulate removal

The only radionuclide expected to be present in significant soluble quantities is uranium All of the listed technologies for dissolved radionuclide removal have been shown to be effective at removing uranium, therefore, this unit operation is selected based on a comparison of the technologies with regard to cost, performance, residue generation, availability, and history of use

Technologies associated with organic and dissolved material removal include reverse osmosis, ultrafiltration, and carbon adsorption

Reverse osmosis (RO) and ultrafiltration (UF) rely on membranes that allow passage of water and the removal of contaminants RO has the capability of isolating water from salts and other molecules UF only isolates water from small particles and large molecules Both RO and UF produce 2 streams - one with a decreased concentration of dissolved materials, the other with an increased concentration of dissolved materials

TABLE 3.1

LIST OF TECHNOLOGIES CONSIDERED IN THE EVALUATION

(1) Water Conditioning Technologies
- Flocculation/Coagulation
  - Alum
  - Ferric Sulfate
  - Clay (montmorillonite)
  - Parallel Plate Separator

- Sludge Dewatering
  - Belt Filter
  - Drum Filter
  - Filter Press

- Clarifier Effluent Polishing
  - Cartridge Filters
  - Bag Filters
  - Sand Filters

(2) Organic Removal Technologies

- Reverse Osmosis
- Ultrafiltration
- Carbon Adsorption

(3) Dissolved Radionuclide Removal Technologies

- Ion Exchange
  - Ionac A641
  - Dowex 21K
  - Zeolites

- Dissolved Material Removal

  - Reverse Osmosis
  - Ultrafiltration
  - Carbon Adsorption

Carbon adsorption-(CA) has been shown to be effective at removing organic chemicals dissolved in water CA would likely be necessary as a preliminary treatment to RO and/or UF in order to prevent organic chemicals from coming in contact with the RO/UF membranes

Ion exchange (IX) was kept separate from dissolved material removal technologies in Table 3 1 to emphasize that IX is being evaluated as a removal method specific for radionuclides IT has had success in identifying ion-specific ion exchange media for past water treatment applications

The technologies listed in Table 3 1 were used to assemble treatment alternatives that each address the three groups of treatment technologies Based on a preliminary evaluation of the effectiveness of each technology and engineering judgment, IT and EG&G personnel selected ten (10) alternatives to be investigated Upon further review of the selected alternatives and receipt of preliminary jar test results, IT added two alternatives (Alternatives 11 and 12) All of the alternatives evaluated in this report are listed in Table 3 2

Key considerations in assembling the alternatives included

- Ability to remove suspended solids
- Ability to remove uranium in dissolved form
- Ability to minimize waste generation
- Ability to remove organic contaminants

In keeping with the assumption that plutonium and americium are primarily associated with suspended solids, water conditioning was examined and combinations of effective solids removal technologies assembled The primary solids removal technologies evaluated were settling with a parallel plate separator ("Lamella ' type clarifier), flotation with a dissolved air flotation (DAF) unit, and filtration with a sand filter having backwash capability that does not interrupt the overall flow of water being filtered

TABLE 3.2

ALTERNATIVES INCLUDED IN EVALUATION

Alternative	Description Parallel Plate Separator
1	Conditioning with "Lamella" type clarifier followed with polishing by sand filtration, carbon adsorption and ion exchange PFDs 304919-B1A and 304919-B1B
2	Same as Alternative 1 except cartridge filtration substitutes for sand filtration PFDs 304919-B2A and 304919-B2B
3	Same as Alternative 1 except ultrafiltration substitutes for ion exchange No PFDs included in this report
4	Same as Alternative 1 except cartridge filtration substitutes for sand filtration and ultrafiltration substitutes for ion exchange No PFDs included in this report
5	Conditioning by sand filtration with backwash of sand filter being handled by a sludge thickener and filter press Polishing is achieved with cartridge filtration, carbon adsorption and ion exchange PFDs 304919-B5A and 304919-B5B
6	Same as Alternative 5 except ultrafiltration substitutes for ion exchange No PFDs included in this report
7	Conditioning with dissolved air flotation followed with polishing by sand filtration, carbon adsorption and ion exchange PFDs 304919-B7A and 304919-B7B
8	Same as Alternative 7 except cartridge filtration substitutes for sand filtration PFDs 304919-B8A and 304919-B8B
9	Same as Alternative 7 except ultrafiltration substitutes for ion exchange No PFDs included in this report
10	Same as Alternative 7 except cartridge filtration substitutes for sand filtration and ultrafiltration substitutes for ion exchange No PFDs included in this report
11	Conditioning by sand filtration with the backwash of the sand filter being handled by a dissolved air flotation unit and filter press Polishing is achieved with cartridge filtration, carbon adsorption and ion exchange PFDs 304919-B11A and 304919-B11B
12	Same as Alternative 11 except ultrafiltration substitutes for ion exchange No PFDs included in this report

Further jar tests on-pond water are needed to determine the "settleability" of the TSS Once this parameter is evaluated, a choice can be made between the settling and flotation technologies. Ideally, pilot-scale tests should be performed using a parallel plate separator, DAF unit and sand filter in order to evaluate solids removal performance

The secondary solids removal technologies evaluated were filtration by sand and a combination of bag and cartridge filters These filtration technologies were incorporated to ensure that suspended solids removal is achieved

Following solids removal, technologies for removal of dissolved organic contaminants and dissolved uranium were incorporated into the alternatives As mentioned previously in this section, technologies evaluated were carbon adsorption, ultrafiltration, reverse osmosis and ion exchange Reverse osmosis was eliminated early in the evaluation of technologies due to its generation of a brine stream high in dissolved solids and uranium The brine stream would be in the range of 25-30% of the total volume of water being treated The remaining technologies were assembled utilizing carbon adsorption for removal of organic contaminants (atrazine and simazine) and either ion exchange or ultrafiltration for uranium removal Carbon adsorption was chosen for organics removal based on its history of effectively removing organic contaminants from aqueous streams

The consideration of minimization of waste was evaluated in assembling the alternatives by attempting to arrange the technologies such that the wastes of concern are concentrated

3 2 COMPARISON OF ALTERNATIVES

The alternatives were compared based on performance at achieving discharge standards, costs and waste generation

Performance evaluations are based on theoretical estimates of technology performance calculated in material balances prepared for each alternative Those alternatives that included ultrafiltration as a final polishing step (Alternatives 3, 4, 6, 9, 10, 12) were screened out prior to the preparation of material balances for reasons noted in Section 1 1 of this report The material balances for ultrafiltration alternatives would be identical to those performed up to the point where UF is used in place of ion exchange

The material balances were performed with certain key assumptions regarding the performance of various proposed technologies These assumptions include

1) Suspended solids removal efficiencies

- "Lamella" type clarifier - 90%
- Dissolved Air Flotation - 95%
- Sludge Thickener - 99%
- Sand Filter - 99 5%
- Filter Press - 100%

2) Uranium Removal Efficiencies

- Ion Exchange (DOWEX 21K) - 99 9%
- Ultrafiltration - 99%

3) Altrazine and Simazine Removal by Carbon Adsorption

- Altrazine - (removed to standard of 0 5 ppb)
- Simazine - (removed to standard of 0 5 ppb)

The efficiencies for suspended solids removal represent typical performance estimates from vendors familiar with the specific pieces of equipment Their estimates are based on a 1500 gpm throughput with suspended solids being approximately 200 ppm after the addition of coagulant and/or flocculent For alternatives in which two of the listed solid/liquid separators are used in series, the overall efficiency was conservatively estimated as being that of the more efficient separator when applied to the inlet (200 ppm) stream Pilot testing is necessary to determine the actual efficiency of two solid/liquid separators in series

An order of magnitude cost estimate was assembled for each alternative based on direct capital costs, indirect capital costs and O&M costs O&M costs are on a per year basis and include 15% of direct capital costs for general maintenance and utilities O&M costs were not generated for teh alternatives utilizing ultrafiltration Wastes are assumed to be all solids generated as a result of treatment and are considered low level waste for disposal at the Nevada Test Site

Waste generation estimates incorporate volumes of waste sludge (in the form of filter cake from filter press), filter media that require periodic changeout, carbon from adsorption units and ion exchange resin The waste generation figures do not include adjustments for solidification Typically waste solidification by cementation adds approximately 50% to the total volume of waste

Tables 3 3, 3 4, and 3 5 summarize data for each alternative with regards to performance, costs and waste generation, respectively The removal efficiencies presented in Table 3 3 are based on inlet concentrations as listed below

<u>Radionuclides</u>	<u>Inlet Concentration</u>
Plutonium	103 pCi/l
Americium	070 pCi/l
Uranium	11 2 pCi/l
<u>Gross Alpha and Beta</u>	
Alpha	11 2 pCi/l
Beta	11 0 pCi/l
<u>Organics</u>	
Atrazine	11 ppb
Simazine	1 9 ppb

As shown in Table 3 3, all of the treatment alternatives meet the discharge standards (see Table 2 4) for the radionuclides and organics of concern

Table 3 4 provides a summary of the estimated capital and operating costs for the alternatives Backup for the costs is provided in Attachment 4

Table 3 5 gives volumes of water for individual sources within the alternatives The numbers for total volume were used in determining disposal and transportation costs

TABLE 3 3

PERFORMANCE CHARACTERISTICS

Alternative	Radionuclide/Organic Contaminant	Discharge Concentration	Percent Reduced from Inlet
1	Plutonium	2 6 E 4 pCi/l	99 7
	Americium	1 8 E 4 pCi/l	99 7
	Uranium	0 011 pCi/l	99 9
	Gross Alpha	0 011 pCi/l	99 9
	Gross Beta	0 028 pCi/l	99 7
	Atrazine	0 5 ppb	95 4
	Simazine	0 5 ppb	73 7
2	Plutonium	7 8 E 5 pCi/l	99 9
	Americium	5 5 E 5 pCi/l	99 9
	Uranium	0 011 pCi/l	99 9
	Gross Alpha	0 011 pCi/l	99 9
	Gross Beta	8 5 E 3 pCi/l	99 9
	Atrazine	0 5 ppb	95 4
	Simazine	0 5 ppb	73 7
5	Plutonium	1 6 E 5 pCi/l	99 9
	Americium	1 1 E 5 pCi/l	99 9
	Uranium	0 011 E 5 pCi/l	99 9
	Gross Alpha	0 011 E 5 pCi/l	99 9
	Gross Beta	1 7 E 3 pCi/l	99 9
	Atrazine	0 5 ppb	95 4
	Simazine	0 5 ppb	73 7
7	Plutonium	2 2 E 4 pCi/l	99 8
	Americium	1 5 E 4 pCi/l	99 8
	Uranium	0 011 E 4 pCi/l	99 9
	Gross Alpha	0 011 E 4 pCi/l	99 9
	Gross Beta	0 024 E 4 pCi/l	99 8
	Atrazine	0 5 ppb	95 4
	Simazine	0 5 ppb	73 7
8	Plutonium	2 6 E 5 pCi/l	99 9
	Americium	1 8 E 5 pCi/l	99 9
	Uranium	0 011 E 5 pCi/l	99 9
	Gross Alpha	0 011 E 5 pCi/l	99 9
	Gross Beta	2 7 E 3 pCi/l	99 4
	Atrazine	0 5 ppb	95 4
	Simazine	0 5 ppb	73 7
11	Plutonium	1 6 E 5 pCi/l	99 9
	Americium	1 1 E 5 pCi/l	99 9
	Uranium	0 011 E 5 pCi/l	99 9
	Gross Alpha	0 011 E 5 pCi/l	99 9
	Gross Beta	1 7 E 3 pCi/l	99 9
	Atrazine	0 5 ppb	95 4
	Simazine	0 5 ppb	73 7

TABLE 3-4
COST SUMMARY

ALTERNATIVE ⟶	1	2	3	4	5	6	7	8	9	10	11	12
DIRECT CAPITAL COSTS	4650000	4920000	5980000	6220000	5400000	6120000	5010000	5270000	5740000	5990000	5480000	6200000
INDIRECT CAPITAL COSTS	4510000	4770000	5790000	6030000	5230000	5930000	4850000	5110000	5560000	5800000	5310000	6010000
TOTAL CAPITAL COST	9160000	9690000	11770000	12250000	10630000	12050000	9860000	10380000	11300000	11790000	10790000	12210000
O&M COSTS (NOTE 1)												
—GENERAL	1370000	1450000	N/A	N/A	1590000	N/A	1480000	1560000	N/A	N/A	1620000	N/A
—WASTE DISPOSAL	266000	333000	N/A	N/A	286000	N/A	277000	309000	N/A	N/A	284000	N/A
TOTAL YEARLY O&M	1640000	1780000	N/A	N/A	1880000	N/A	1760000	1870000	N/A	N/A	1900000	N/A

1.1 General
Treatment plant Manual

NOTE (1) O&M costs were not developed for the alternatives that included ultrafiltration for uranium removal

TABLE 3 5

SUMMARY OF WASTE GENERATION - FT^3/YR
(prior to solidification)

Alternative	Waste Type	Volume of Specific Media	Total Volume
1	Carbon	899	9,100
	Ix Resin	400	
	Solids (Sludge)	7,730	
	Filter Bags	76	
2	Carbon	899	12,800
	Ix Resin	400	
	Solids (Sludge)	7,730	
	Filter Bags	2,373	
	Cartridge Filters	1,397	
5	Carbon	899	10,200
	Ix Resin	400	
	Solids (Sludge)	8,580	
	Filter Bags	5	
	Cartridge Filters	283	
7	Carbon	899	9,700
	Ix Resin	400	
	Solids (Sludge)	8,300	
	Filter Bags	64	
8	Carbon	899	11,500
	Ix Resin	400	
	Solids (Sludge)	8,300	
	Filter Bags	1,188	
	Cartridge Filters	719	
11	Carbon	899	10,100
	Ix Resin	400	
	Solids (Sludge)	8,230	
	Filter Bags	125	
	Cartridge Filters	283	

4.0 MATERIAL BALANCE CALCULATIONS

The material balance calculations provide the basis for comparison of the effectiveness of the alternatives in meeting the design basis requirements for removal They also provide estimates for residue generation rates Attachment 1 provides copies of the material balance calculations The process flow diagrams (PFDs) are included in Attachment 2 for Alternatives 1, 2, 5, 7, 8, and 11 The PFDs provide the results of the material balance calculations This section provides a summary of the methods used to calculate material balances

The material balances presented in this report were based primarily on vendor conversations Vendors were contacted to obtain data on the treatment efficiencies, residue generation, operating requirements and costs for equipment that might be used as a part of an evaluated alternative Table 4 1 provides a list of all vendors contacted and the equipment they provide Some of these vendors represent equipment which will be recommended for pilot testing Further discussion of such testing is included in Section 5 0

Data on treatment systems were also obtained from literature sources, IT in-house data, and data provided by EG&G, Rocky Flats Table 4 2 provides a list of literature sources used during this project

The material balances provide the mass flow of key parameters and contaminants of concern throughout the technologies included in the individual treatment alternatives. This provides a convenient resource which shows the function and efficiency of each major piece of equipment shown in each alternative Parameters tracked in the material balance include the plutonium, americium and uranium, gross alpha and beta, the herbicides atrazine and simazine; and the bulk parameters mass flow of water, mass flow of solids, temperature, density, pH and total dissolved solids (TDS)

TABLE 4 1

VENDOR CONTACT LIST

Vendor Contact	Company	Equipment
Doug Lindsey (D H Lindsey Co) Tom Moritti (Misco Rocky Mtn) Byron Bergman (Centennial Equipment) *Hollie Scott (Eimco Equipment Co) Gordon Blackwell (Canyon Systems, Inc	Infilco Degremont, Inc Parkson Corporation ERC/Lancy Eimco Equipment Co DAVCO Systems	Clarifiers/Thickeners
Bob Hughart (Applications Corporation) Doug Lindsey (D H Lindsey Co) Gordon Blackwell (Canyon Systems, Inc)	Komline Sanderson Co Infilco Degremont, Inc DAVCO Systems	D A F Units
Hollie Scott (Eimco Equipment Co) Clark Tuck (Falcon Supply Co) Dean S Lewis (Culligan Inc) Gordon Blackwell (Canyon Systems, Inc)	Eimco Equipment Co Smith & Loveless, Inc Culligan, Inc DAVCO Systems	Filters (Sand, Cartridge)
Byron Bergman (Centennial Equipment) Dean S Lewis (Culligan Inc) Gordon Blackwell (Canyon Systems, Inc)	IWT Himsley Co Culligan Inc Western Filter Corp	Ion Exchange, RO, UF
Clark Tuck (Falcon Supply Co) Paul Favia (Acricson, Inc) Gordon Blackwell (Canyon Systems, Inc)	Stranco Acrison, Inc	Polymer Feed System
Chris Beck (D W Daigler) Gordon Blackwell (Canyon Systems, Inc)	Plas Tank, Inc DAVCO Systems	Tanks
Chris Beck (D W Daigler) Bob Hughart (Applications Corporation) Clark Tuck (Falcon Supply Co)	Lightin Appcor Smith & Loveless, Inc Philadelphia	Mixers
Frank Haggerty (Eagle Pump & Equipment) Herbert Welch (Crisafulli)	Goulds Pumps, Inc Crisafulli Pump Co	Pumps (Centrifugal, Low-Shear)
Chris Beck (D W Daigler) Bob Hughart (Applications Corporation) *Hollie Scott (Eimco Equipment Co) Gordon Blackwell (Canyon Systems, Inc)	Shriver Komline Sanderson Co Eimco Equipment Co DAVCO Systems	Filter Presses

* Vendors not found in the Denver area

TABLE 4 2

LITERATURE SOURCES USED IN THE MATERIAL BALANCE CALCULATIONS

- Lowry, J D , Lowry, S B , 1988, "Radionuclides in Drinking Water," Journal of AWWA, June 1988, pp 50-64

- Thompson, M A , "Plutonium in the Aquatic Environment Around the Rocky Flats Facility," USAEC Contract Number AT (29-1) 1106, Document Number IAEA-SM-198138

- Illinois Water Treatment Company, 1986, "IWT-Himsely Continuous Fluidized Beds and Continuous Moving Packed Beds," Making Waves in Liquid Processing, Volume 3 Number 1

- Jelinek, R T , Sorg, T J , 1988, "Operating a Full-Scale Ion Exchange System for Uranium Removal," Journal of AWWA, July 1988

- Palmer, C , Himsley, A , et al , 1984, "Design and Operation of Continuous Ion Exchange Process for Treating Uranium Mine Water," 45th International Water Conference, Pittsburg, Pennsylvania, October 1984

- Penrose, W R , Polzer, W L , et al , 1990, "Mobility of Plutonium and Americium through a Shallow Aquifer in a Semiarid Region," Environmental Science Technology, Volume 24 Number 2

- Murray, C N , Fukai, R , "Adsorption-Desorption Characteristics of Plutonium and Americium with Sediment Particles in the Estuarine Environment Studies using Plutonium-237 and Americium-241," International Laboratory of Marine Radioactivity

- Hanson, S W , Wilson, D B , et al , EPA 1987, "Removal of Uranium from Drinking Water by Ion Exchange and Chemical Clarification," EPA/600/52-87/076, USEPA Cincinnati, 1987

- Lefeure, L J , 1986, "Ion Exchange Problems and Troubleshooting," Chemical Engineering, July 7, 1986

- Edzwald, J K , Mallery, Jr , J P , EPA 1990, "Removal of Humic Substances and Algae by Dissolved Air Flotation,' EPA/600/52-89/032, USEPA Cincinnati, February 1990

- Sorg, T J , 1988, "Methods of Removing Uranium from Drinking Water," Journal of the AWWA, Volume 80, pp 105-111

TABLE 4.2

LITERATURE SOURCES USED IN THE MATERIAL BALANCE CALCULATIONS
(continued)

- Orlando, K A , Penrose, W R , et al , 1990, "Colloidal Behaviour of Actinides in an Oligotrophic Lake," Environmental Science Technology, Volume 24 Number 5, pp 706-712

Major assumptions used to perform the material balance calculations are as follows

- The treatment efficiency of two solids separation technologies used in series was assumed to equal the single efficiency of the more efficient technology used alone This assumption was made since the overall efficiency should be between the single technology efficiency and the multiplicative efficiency of the two systems When two systems are used in series, a finite percentage of the material removed (in this case, suspended solids) is difficult to capture by either system due to particle size, surface characteristics or density These particles represent some fraction of what is observed to not be removed Another fraction is not removed due to inefficiencies of each system in removal of solids such as short circuiting, mixing, or the probalistic nature of many solids removal technologies Since the relative amounts of these two fractions is not defined, the overall removal of two technologies in series cannot be accurately estimated Use of the efficiency of the more efficient of the two technologies represents a conservative assumption for overall removal

- The density of dilute solutions is assumed to be equal to the density of water unless otherwise specified

- Plutonium, americium and gross beta are assumed to be associated with suspended solids and have a soluble concentration of zero

- Uranium, gross alpha, atrazine and simazine are assumed to be associated with the water only and have 100% solubility at the concentrations present

5 0 RECOMMENDATIONS FOR PILOT TESTING

As summarized in Section 1 2, further bench-scale tests supplemented with pilot-scale tests are necessary to make a justifiable selection of a treatment alternative

Bench tests in the form of jar tests were performed by Bob Holland of Nalco Chemical Company in late July, 1990 Mr Holland performed basic tests on Pond B-5 water to determine an effective dose of coagulant and flocculent needed to form a floc of the suspended solids Based on available data, B-5 typically has the highest concentration of suspended solids of Ponds A-4, B-5 and C-2 The jar tests showed that a dose of cationic coagulant at 60 ppm followed by a 0 5 - 1 0 ppm dose of anionic flocculent allowed a large, light floc to form Some of the floc floated until clay was added, causing the floc to settle very rapidly To further clarify the above bench tests, the following additional bench tests should be performed

1) Jar tests on Pond A-4 and Pond C-2 water should be conducted investigating the same parameters as those investigated for Pond B-5 This would allow refining of critical numbers regarding waste generation, costs, and performance since the treatment alternatives incorporate designs to handle the worst case solids loading associated with Pond B-5

2) Further evaluation needs to be conducted on the ability to cause floc to settle by adding clay This evaluation should establish the type and dose of clay required

Pilot-scale tests should be conducted to evaluate the performance of the following technologies

- Solid/Liquid separation by a parallel plate ("Lamella" type) separator
- Solid/Liquid separation by dissolved air flotation
- Solid/Liquid separation by sand filtration (including backwash requirements)

Each of these technologies is included as an option for the primary solid/liquid separation unit operation needed in each alternative All pilot tests must be performed while simulating the conditions as represented in the process flow diagrams incorporating the above technologies

Each of the vendors capable of supplying pilot testing equipment expressed a concern over the liabilities associated with contamination of rented equipment The vendors are therefore making the rental fee equal to the purchase price

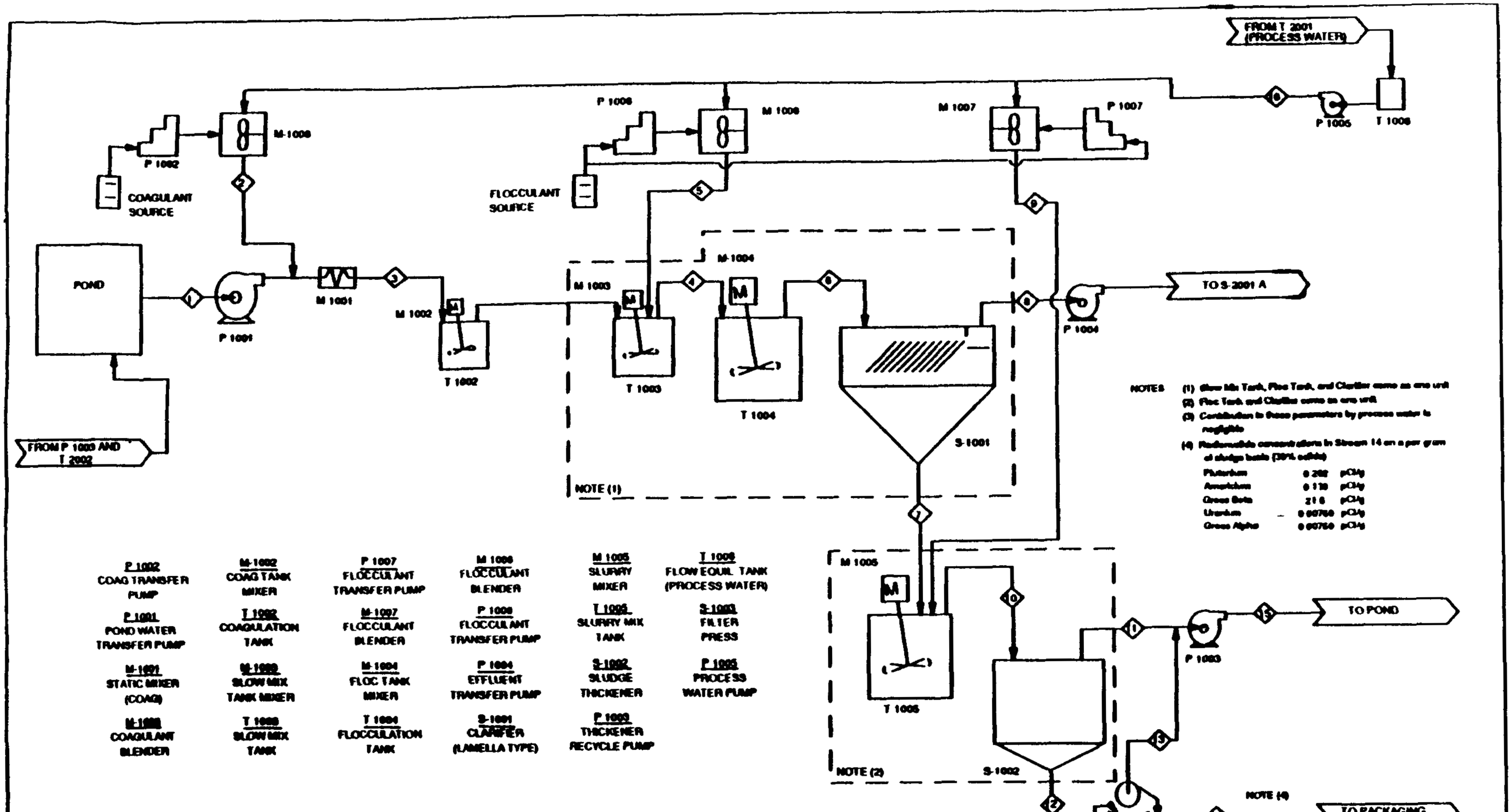
Based on conversations with vendors, availability of equipment and general knowledge of the requirements for a treatment system, IT recommends coordinating pilot testing through DAVCO Systems which is represented locally by Mr Gordon Blackwell of Canyon Systems, Inc The following summarizes the pilot units DAVCO can provide

1) Dissolved Air Flotation (DAF) - DAVCO can provide an 8-foot diameter unit rated at 100 gpm The system includes a rapid mix zone, mixer, flocculation zone, flocculator and drive, flotation tank with scrapers and skimmers, recycle pressurization skid with air compressor/motor, recycle pump/motor, ASME pressure tank, all piping/valves, pH controller with acid and caustic feed systems, polymer feed system and all controls Costs for delivery of such a unit to the site and set up for operation would be approximately $100,000 00

2) Travelling Bridge Sand Filter - DAVCO can provide a fully operational unit rated at 100 gpm The complete system delivered to the site would be approximately $60,000 00

3) Parallel Plate Separator - DAVCO can supply several sizes of parallel plate separators The units are complete with rapid-mix zone, mixer, flocculation zone, flocculator, clarifier with sample taps, pH controller and chemical feed pumps A 100 gpm unit delivered to the site and set up for operation would cost approximately $60,000 00 A 10 gpm unit would cost approximately $45,000 00

Testing of both the DAF and parallel plate separators may be unnecessary depending on the results of the recommended bench tests If the amount of clay needed to cause the suspended solid to settle adds significantly to the sludge generated by treatment, then solid/liquid separation by settling should be abandoned and attention focused on flotation



P 1002 COAG TRANSFER PUMP
P 1001 POND WATER TRANSFER PUMP
M-1001 STATIC MIXER (COAG)
M-1008 COAGULANT BLENDER
M-1002 COAG TANK MIXER
T 1002 COAGULATION TANK
M-1003 SLOW MIX TANK MIXER
T 1003 SLOW MIX TANK
P 1007 FLOCCULANT TRANSFER PUMP
M-1007 FLOCCULANT BLENDER
M-1004 FLOC TANK MIXER
T 1004 FLOCCULATION TANK
M 1006 FLOCCULANT BLENDER
P 1006 FLOCCULANT TRANSFER PUMP
P 1004 EFFLUENT TRANSFER PUMP
S-1001 CLARIFIER (LAMELLA TYPE)
M 1005 SLURRY MIXER
T 1005 SLURRY MIX TANK
S-1002 SLUDGE THICKENER
P 1003 THICKENER RECYCLE PUMP
T 1006 FLOW EQUIL TANK (PROCESS WATER)
S-1003 FILTER PRESS
P 1005 PROCESS WATER PUMP

NOTES
(1) Slow Mix Tank, Floc Tank, and Clarifier come as one unit
(2) Floc Tank and Clarifier come as one unit
(3) Contribution to these parameters by process water is negligible
(4) Radionuclide concentrations in Stream 14 on a per gram of sludge basis (30% solids)

Plutonium	0 202	pCi/g
Americium	0 130	pCi/g
Gross Beta	21 6	pCi/g
Uranium	0 00760	pCi/g
Gross Alpha	0 00760	pCi/g

STREAM NUMBER		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
COMPONENT		POND WATER	COAG SOLU'N	COAG SLURRY	FLOC SLURRY	FLOC SOLU'N	FLOC SLURRY	CLAR SLUDGE	CLAR EFFLUENT	FLOC SOLU'N	FLOC SLUDGE	THICKNER EFFLUENT	THICKNER SLUDGE	PRESS EFFLUENT	PRESS CAKE	RECYCLE	PROCESS WATER
MASS FLOW (WATER) LB/MIN		12512	14 20	12526	12526	1 24	12520	82 6	12446	0 0043	82 6	42 6	40 0	35 0	3 04	78 1	16
MASS FLOW (SOLIDS) LB/MIN		1 25	0	2 02	2 03	0	2 03	1 03	0 20	0	1 03	0 02	1 01	0	1 01	0 02	NOTE (3)
TEMPERATURE		AMB	AMB	AMB	AMB	AMB	AMB	AMB	AMB	AMB	AMB	AMB	AMB	AMB	AMB	AMB	
SUSP SOLIDS DENSITY	LB/FT3	62 4	N/A	67 0	67 0	N/A	67 0	67 0	67 0	N/A	67 0	67 0	67 0	N/A	67 0	67 0	
LIQUID DENSITY	LB/FT3	62 4	62 4	62 4	62 4	62 4	62 4	62 4	62 4	62 4	62 4	62 4	62 4	62 4	62 4	62 4	
pH		7 10		7 10	7 10		7 10	7 10	7 10		7 10	7 10	7 10	7 10	7 10	7 10	
TDS	LB/MIN	1 75	0 752	1 75	1 75	0 0125	1 75	0 011	1 74	8 44E 6	0 011	0 0057	0 0051	0 0046	8 1E 4	0 0106	
PLUTONIUM	pCi/MIN	500	0	500	500	0	500	621	57	0	621	6 72	610	0	610	6 72	
AMERICIUM	pCi/MIN	400	0	400	400	0	400	360	40	0	360	3 94	354	0	354	3 94	
GROSS BETA	pCi/MIN	62000	0	62000	62000	0	62000	65000	6100	0	65000	611	65201	0	65201	611	
URANIUM	pCi/MIN	63600	0	63600	63600	0	63600	419	63200	0	419	210	209	102	19 6	390	
GROSS ALPHA	pCi/MIN	63600	0	63600	63600	0	63600	419	63200	0	419	210	209	102	19 6	390	
ATRAZINE	LB/MIN	1 40E 4	0	1 40E 4	1 40E 4	0	1 40E 4	9 22E 7	1 40E 4	0	9 22E 7	4 00E 7	4 00E 7	4 16E 7	4 4E 8	9 0E 7	
SIMAZINE	LB/MIN	2 40E 5	0	2 40E 5	2 40E 5	0	2 40E 5	1 64E 7	2 40E 5	0	1 64E 7	8 20E 8	7 80E 8	7 05E 8	7 6E 8	1 52E 7	

IT CORPORATION

ROCKY FLATS PLANT
GOLDEN COLORADO

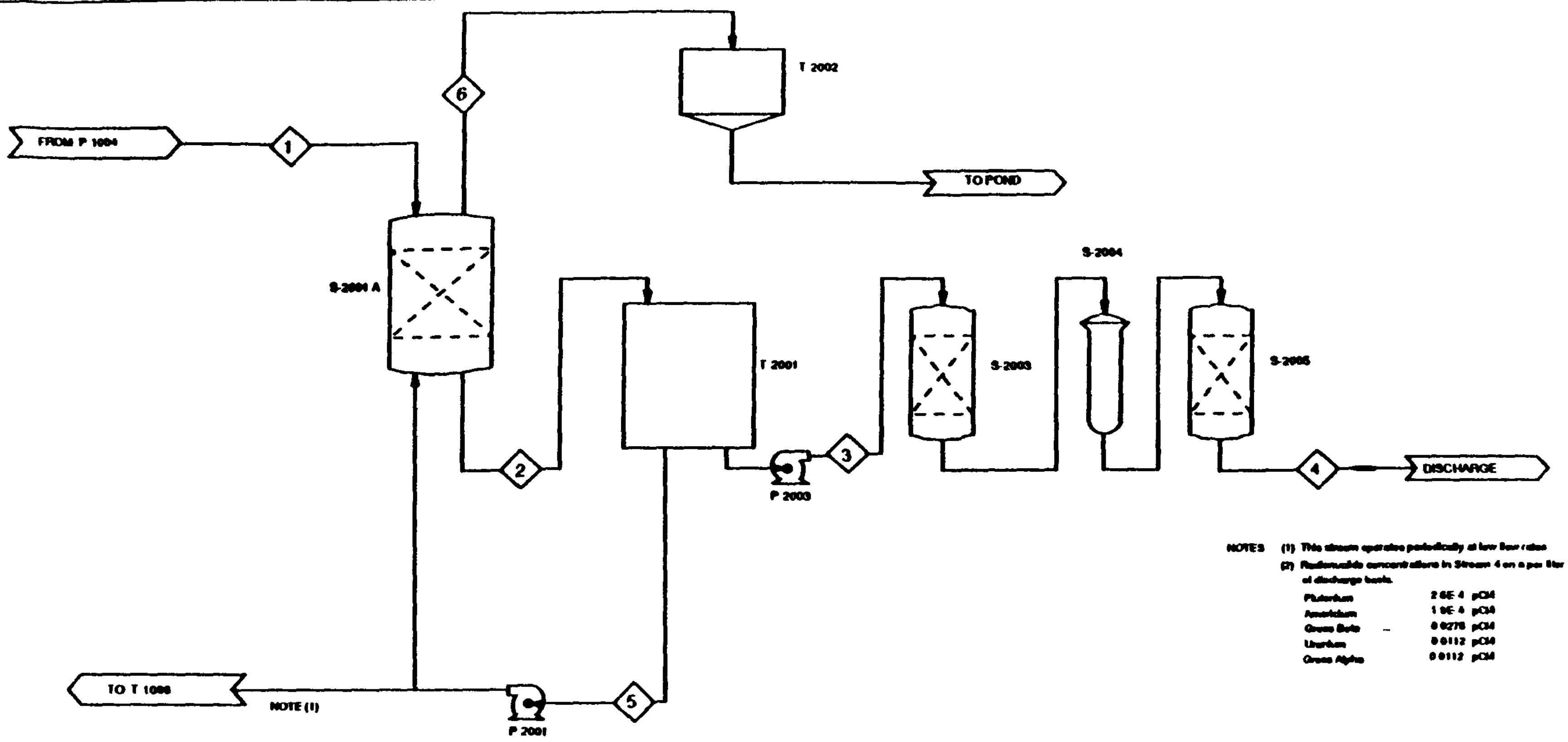
SOLIDS REMOVAL
UTILIZING A PARALLEL PLATE SEPARATOR

FOR INFORMATION ONLY

ALTERNATIVE I
PROCESS FLOW DIAGRAM
CONDITIONING

ALTIC DRW

DATE		JOB NUMBER	DWG No	304919 B1A	REV 0
SCALE	NONE	304919			



NOTES (1) This stream operates periodically at low flow rates
(2) Radionuclide concentrations in Stream 4 on a per liter of discharge basis.

Plutonium	2.6E-4	pCi/l
Americium	1.9E-4	pCi/l
Gross Beta	0.0278	pCi/l
Uranium	0.0112	pCi/l
Gross Alpha	0.0112	pCi/l

S-2001 A SAND FILTER
P 2001 BACKWASH TRANSFER PUMP
S-2003 CARBON ADSORBER
T-2001 BACKWASH WATER TANK
T 2002 FLOW EQUILIZATION TANK
S-2004 BAG FILTERS
P-2003 BOOSTER PUMP
S-2005 ION EXCHANGE

STREAM NUMBER		1	2	3	4	5	6									
COMPONENT		POLISH. INFLUENT	S. FILTER EFFLUENT	CARB INFLUENT	DISCH.	BACKWASH WATER	BACKWASH EFFLUENT									
MASS FLOW (WATER) LB/MIN		12446	12446	11977	11977	480	480									
MASS FLOW (SOLIDS) LB/MIN		0.20	0.0102	0.00082	0.00401	3.04E-4	0.190									
TEMPERATURE		AMB	AMB	AMB	AMB	AMB	AMB									
SUSP. SOLIDS DENSITY	LB/FT3	67.0	67.0	67.0	67.0	67.0	67.0									
LIQUID DENSITY	LB/FT3	62.4	62.4	62.4	62.4	62.4	62.4									
pH		7.10	7.10	7.10	7.10	7.10	7.10									
TDS	LB/MIN	1.74	1.74	1.07	1.07	0.0056	0.0056									
PLUTONIUM	pCi/MIN	57	2.01	2.00	1.40	0.110	64.2									
AMERICIUM	pCi/MIN	40	2.04	1.00	0.900	0.0700	30.0									
GROSS BETA	pCi/MIN	6100	311	200	180	11.7	6400									
URANIUM	pCi/MIN	63200	63200	60000	60.0	2400	2400									
GROSS ALPHA	pCi/MIN	63200	63200	60000	60.0	2400	2400									
ATRAZINE	LB/MIN	1.40E-4	1.40E-4	1.30E-4	5.90E-6	6.20E-6	6.20E-6									
SIMAZINE	LB/MIN	2.40E-6	2.40E-6	2.31E-6	6.00E-6	9.06E-7	9.06E-7									

IT CORPORATION

ROCKY FLATS PLANT
GOLDEN COLORADO

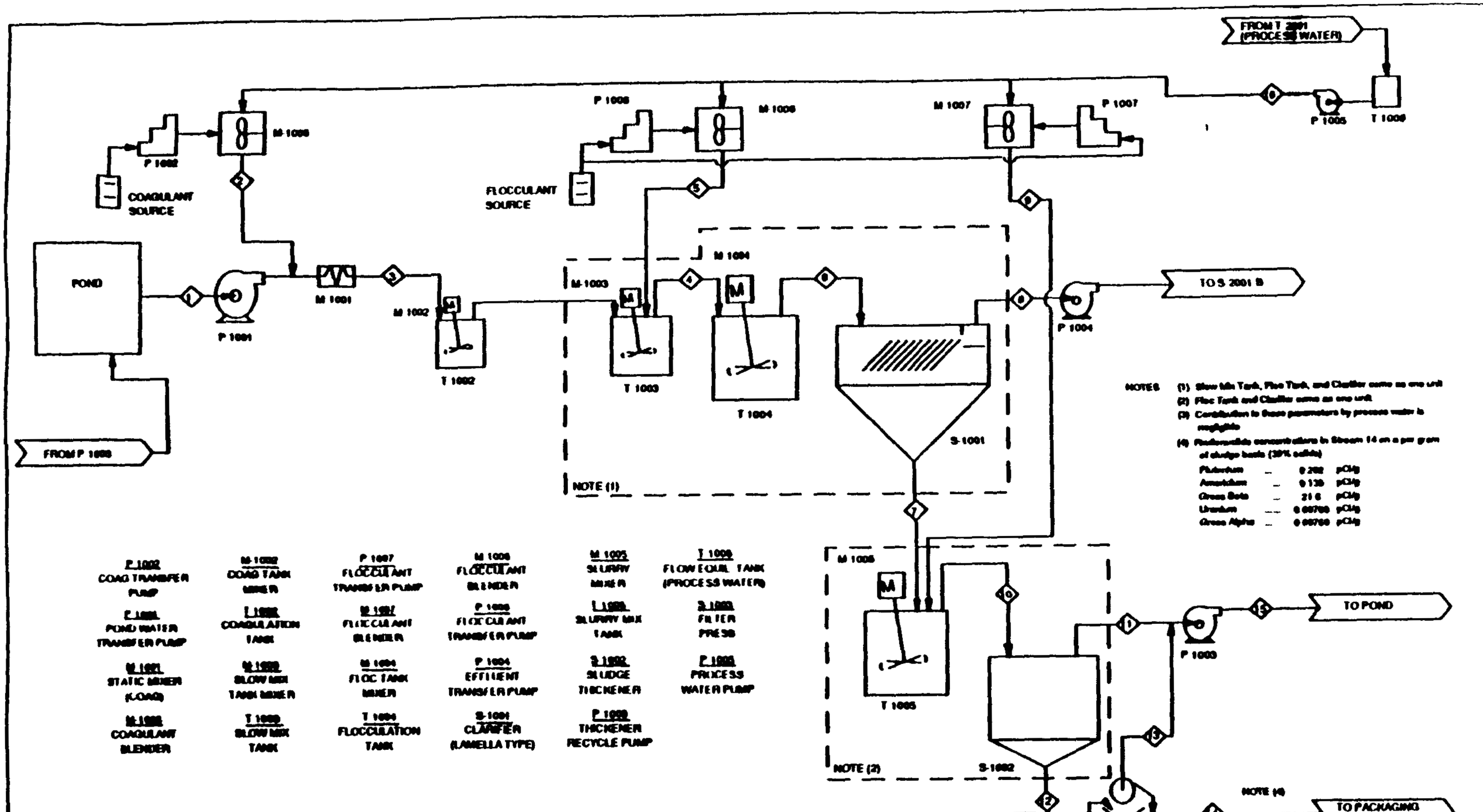
EFFLUENT POLISHING BY
CARBON ADSORPTION, ION EXCHANGE & FILTRATION

FOR INFORMATION ONLY

ALTERNATIVE 1
PROCESS FLOW DIAGRAM
POLISHING

ALT 1 P DRW

DATE		JOB NUMBER	DWG No	304919 B1B	REV 0
SCALE	NONE	304919			



NOTES
(1) Slow Mix Tank, Floc Tank, and Clarifier come as one unit
(2) Floc Tank and Clarifier come as one unit
(3) Contribution to these parameters by process water is negligible
(4) Radionuclide concentrations in Stream 14 on a per gram of sludge basis (30% solids)

Plutonium	–	0.202	pCi/g
Americium	–	0.130	pCi/g
Gross Beta	–	21.6	pCi/g
Uranium	–	0.00700	pCi/g
Gross Alpha	–	0.00700	pCi/g

P 1002 COAG TRANSFER PUMP
P 1001 POND WATER TRANSFER PUMP
M 1001 STATIC MIXER (COAG)
M 1000 COAGULANT BLENDER
M 1002 COAG TANK MIXER
T 1002 COAGULATION TANK
M 1003 SLOW MIX TANK MIXER
T 1003 SLOW MIX TANK
P 1007 FLOCCULANT TRANSFER PUMP
M 1007 FLOCCULANT BLENDER
M 1004 FLOC TANK MIXER
T 1004 FLOCCULATION TANK
M 1006 FLOCCULANT BLENDER
P 1008 FLOCCULANT TRANSFER PUMP
P 1004 EFFLUENT TRANSFER PUMP
S-1001 CLARIFIER (LAMELLA TYPE)
M 1005 SLURRY MIXER
T 1005 SLURRY MIX TANK
S 1002 SLUDGE THICKENER
P 1009 THICKENER RECYCLE PUMP
T 1006 FLOW EQUIL TANK (PROCESS WATER)
S 1003 FILTER PRESS
P 1005 PROCESS WATER PUMP

STREAM NUMBER		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
COMPONENT		POND WATER	COAG SOLUT'N	COAG SLURRY	FLOC SLURRY	FLOC SOLUT'N	FLOC SLURRY	CLAR SLUDGE	CLAR EFFLUENT	FLOC SOLUT'N	FLOC SLUDGE	THICKNR EFFLUENT	THICKNR SLUDGE	PRESS EFFLUENT	PRESS CAKE	RECYCLE	PROCESS WATER
MASS FLOW (WATER) LB/MIN		12512	14.28	12526	12528	1.24	12528	82.5	12446	0.0043	82.8	42.6	40.0	35.0	3.84	78.3	16
MASS FLOW (SOLIDS) LB/MIN		1.25	0	2.02	2.03	0	2.03	1.83	0.20	0	1.83	0.02	1.81	0	1.81	0.02	NOTE (3)
TEMPERATURE		AMB	AMB	AMB	AMB	AMB	AMB	AMB	AMB	AMB	AMB	AMB	AMB	AMB	AMB	AMB	
SUSP. SOLIDS DENSITY	LB/FT3	62.4	N/A	67.0	67.0	N/A	67.0	67.0	67.0	N/A	67.0	67.0	67.0	N/A	67.0	67.0	
LIQUID DENSITY	LB/FT3	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4	
pH		7.10		7.10	7.10		7.10	7.10	7.10		7.10	7.10	7.10	7.10	7.10	7.10	
TDS	LB/MIN	1.75	0.752	1.75	1.75	0.0125	1.75	0.011	1.74	0.44E-6	0.011	0.0067	0.0063	0.0045	6.1E-4	0.0105	
PLUTONIUM	pCi/MIN	500	0	500	500	0	500	623	61	0	629	6.72	510	0	610	6.72	
AMERICIUM	pCi/MIN	400	0	400	400	0	400	360	40	0	360	3.94	356	0	356	3.94	
GROSS BETA	pCi/MIN	62000	0	62000	62000	0	62000	55000	6100	0	55000	611	55201	0	55201	611	
URANIUM	pCi/MIN	63600	0	63600	63600	0	63600	410	63200	0	410	216	203	182	19.5	300	
GROSS ALPHA	pCi/MIN	63600	0	63600	63600	0	63600	410	63200	0	410	216	203	182	19.8	300	
ATRAZINE	LB/MIN	1.40E-4	0	1.40E-4	1.40E-4	0	1.40E-4	0.22E-7	1.40E-4	0	0.22E-7	4.00E-7	4.60E-7	4.16E-7	4.4E-9	9.0E-7	
SIMAZINE	LB/MIN	2.40E-5	0	2.40E-5	2.40E-5	0	2.40E-5	1.64E-7	2.40E-6	0	1.64E-7	0.20E-8	7.00E-8	7.05E-8	7.5E-9	1.62E-7	

IT CORPORATION

ROCKY FLATS PLANT
GOLDEN, COLORADO

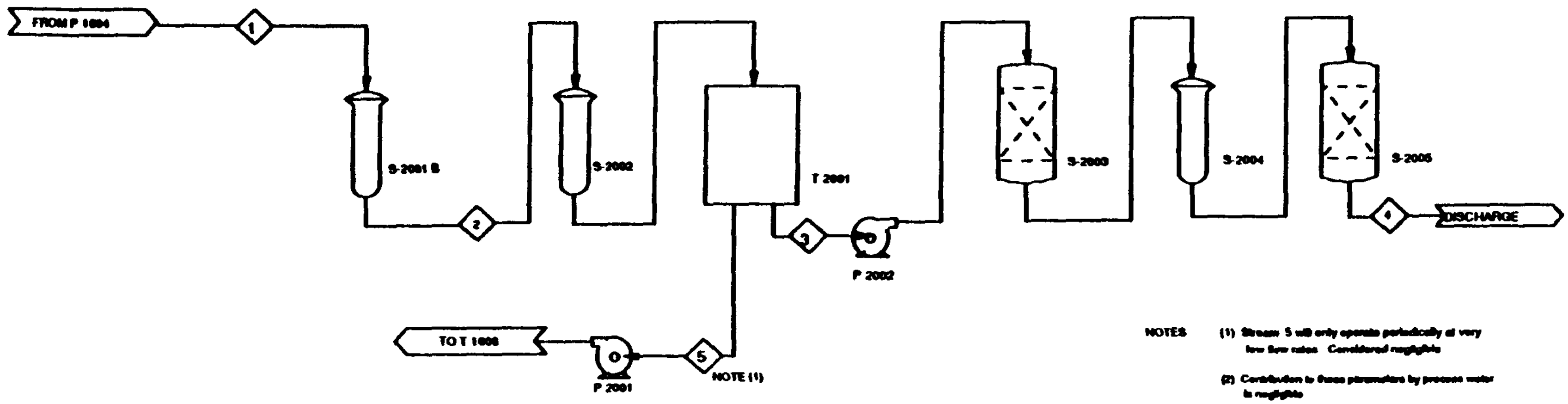
SOLIDS REMOVAL
UTILIZING A PARALLEL PLATE SEPARATOR

FOR INFORMATION ONLY

ALTERNATIVE 2
PROCESS FLOW DIAGRAM
CONDITIONING

ALT2C DRW

DATE		JOB NUMBER	DWG No.	REV
SCALE	NONE	304919	304919 B2A	0



S-2002 CARTRIDGE FILTERS

S-2001 B BAG FILTERS

S-2003 CARBON ADSORBER

S-2004 BAG FILTERS

S-2005 ION EXCHANGE

T-2001 PROCESS WATER TANK

P 2001 PROCESS WATER TRANSFER PUMP

P-2002 BOOSTER PUMP

NOTES

(1) Stream 5 will only operate periodically at very low flow rates. Considered negligible

(2) Contribution to these parameters by process water is negligible

(3) Radionuclide concentrations in Stream 5 on a per liter of discharge basis.

Plutonium	7 78E 5	pCi/l
Americium	5 40E 5	pCi/l
Gross Beta	8 50E 3	pCi/l
Uranium	0 0112	pCi/l
Gross Alpha	0 0112	pCi/l

STREAM NUMBER		1	2	3	4	5									
COMPONENT		POLISH INFLUENT	CART INFLUENT	CARX INFLUENT	DISCH	PROCESS WATER									
MASS FLOW (WATER) LB/MIN		12446	12446	12446	12446	16									
MASS FLOW (SOLIDS) LB/MIN		0 20	0 046	0 0001	0 0016	NOTE (2)									
TEMPERATURE		AMB	AMB	AMB	AMB										
SUSP. SOLIDS DENSITY	LB/FT3	67 8	67 0	67 8	67 8										
LIQUID DENSITY	LB/FT3	62 4	62 4	62 4	62 4										
pH		7 10	7 10	7 10	7 10										
TDS	LB/MIN	1 74	1 74	1 74	1 74										
PLUTONIUM	pCi/MIN	57	13 7	0 80	0 44										
[illegible]	pCi/MIN	40	0 80	0 42	0 31										
[illegible]	pCi/MIN	6100	1400	65	40										
[illegible]	pCi/MIN	[illegible]	[illegible]	63200	62 2										
[illegible]	pCi/MIN	[illegible]	[illegible]	[illegible]	62 2										
[illegible]	LB/MIN	1 42 4	1 42 4	1 42 4	0 28 6										
[illegible]	LB/MIN	2 45 5	2 45 5	2 45 5	0 25 6										

ALT2P DRW

IT CORPORATION

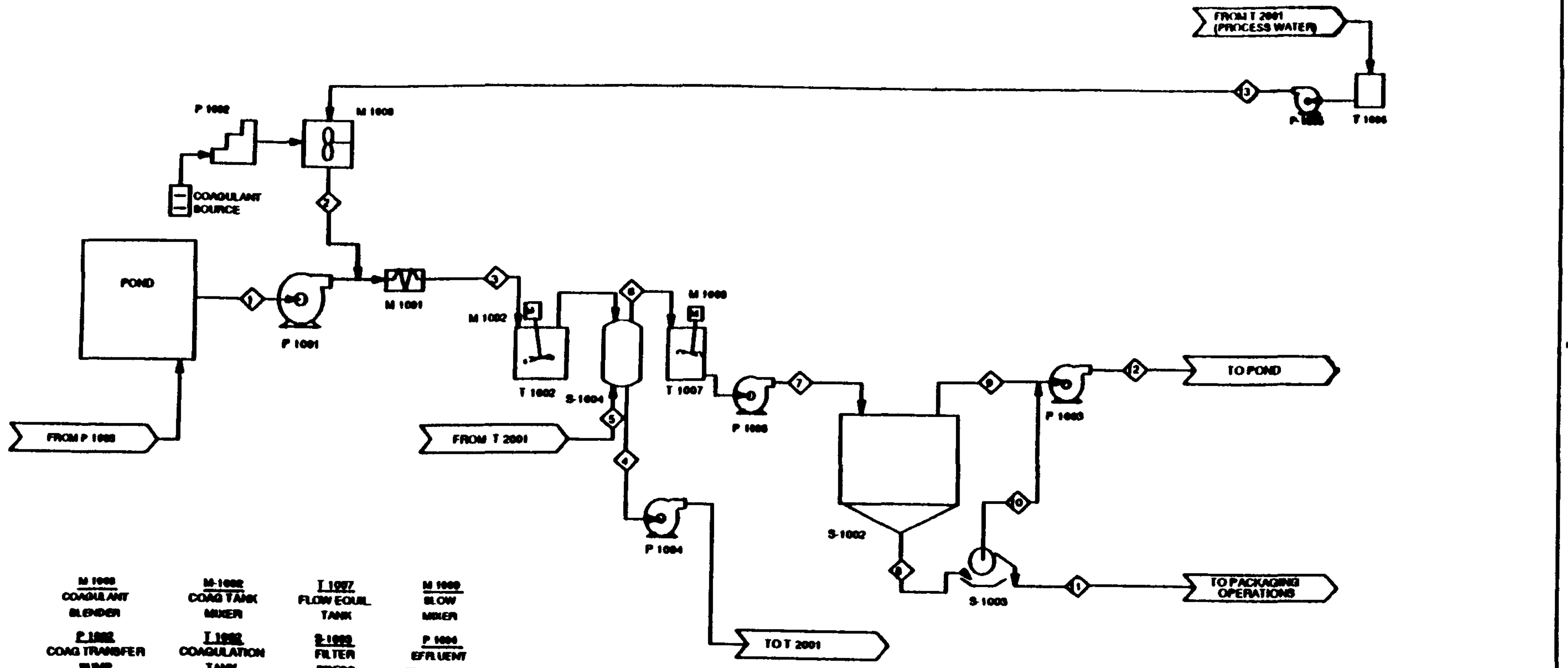
ROCKY FLATS PLANT
GOLDEN, COLORADO

EFFLUENT POLISHING BY
FILTRATION, CARBON ADSORPTION & ION EXCHANGE

FOR INFORMATION ONLY

ALTERNATIVE 2
PROCESS FLOW DIAGRAM
POLISHING

DATE		JOB NUMBER	DWG No	REV
SCALE	NONE	3049 0	304919 B2B	0



M 1000 COAGULANT BLENDER	M-1002 COAG TANK MIXER	T 1007 FLOW EQUIL TANK	M 1009 SLOW MIXER
P 1002 COAG TRANSFER PUMP	T 1002 COAGULATION TANK	S-1003 FILTER PRESS	P 1004 EFFLUENT TRAN PUMP
P 1001 POND WATER TRANSFER PUMP	P 1003 SLUDGE TRANSFER PUMP	S-1004 SAND FILTER	T 1006 FLOW EQUIL (PROCESS WATER)
M-1001 STATIC MIXER (COAG)	S-1002 SLUDGE THICKENING TANK	P-1008 RECYCLE PUMP	P 1005 PROCESS WATER PUMP

NOTES (1) Contribution of these parameters by process water is negligible

(2) Radionuclide concentrations in Stream 11 on a per gram of sludge basis (30% solids)

Plutonium	0 200	pCi/g
Americium	0 130	pCi/g
Gross Beta	21 5	pCi/g
Uranium	0 00702	pCi/g
Gross Alpha	0 00702	pCi/g

STREAM NUMBER		1	2	3	4	5	6	7	8	9	10	11	12	13		
COMPONENT		POND WATER	COAG SOLUTN	COAG SLURRY	S FILTER EFFLUENT	BCKWASH WATER	BCKWASH EFFLUENT	CLAR INFLUENT	THICKEN SLUDGE	THICKEN OVERFLOW	PRESS FILTRATE	PRESS CAKE	RECYCLE	PROCESS WATER		
MASS FLOW (WATER) LB/MIN		12512	14 28	12526	12526	460	460	460	44 0	425	39 7	4 28	465	10		
MASS FLOW (SOLIDS) LB/MIN		1 25	0	2 02	0 0101	3 70E 4	2 01	2 01	1 99	0 02	0	1 90	0 02	NOTE (1)		
TEMPERATURE		AMB	AMB	AMB	AMB	AMB	AMB	AMB	AMB	AMB	AMB	AMB	AMB			
SUSP SOLIDS DENSITY	LB/FT3	62 4	N/A	67 0	67 0	67 0	67 0	67 0	67 0	67 0	N/A	67 5	67 0			
LIQUID DENSITY	LB/FT3	62 4	62 4	62 4	62 4	62 4	62 4	62 4	62 4	62 4	62 4	62 4	62 4			
pH		7 10		7 10	7 10	7 10	7 10	7 10	7 10	7 10	7 10	7 10	7 10			
TDS	LB/MIN	1 75	0 752	1 75	1 75	0 0656	0 0656	0 0656	0 00615	0 0504	0 00555	5 00E 4	0 0650			
PLUTONIUM	pCi/MIN	500	0	500	2 0	0 110	577	577	571	6 0	0	571	6 0			
AMERICIUM	pCi/MIN	400	0	400	2 0	0 0749	390	390	394	4 0	0	394	4 0			
GROSS BETA	pCi/MIN	62000	0	62000	310	11 6	61700	61700	61100	600	0	61100	600			
URANIUM	pCi/MIN	63600	0	63600	63600	2300	2300	2300	223	2100	201	21 7	2360			
GROSS ALPHA	pCi/MIN	63000	0	63600	63600	2300	2300	2300	223	2100	201	21 7	2300			
ATRAZINE	LB/MIN	1 4E 4	0	1 4E 4	1 4E 4	5 24E 6	5 24E 6	5 24E 6	4 92E 7	4 75E 6	4 44E 7	4 70E 8	5 20E 6			
SIMAZINE	LB/MIN	2 4E 5	0	2 4E 5	2 4E 5	8 90E 7	8 90E 7	8 90E 7	8 43E 8	8 15E 7	7 61E 8	8 20E 9	8 01E 7			

IT CORPORATION

ROCKY FLATS PLANT
GOLDEN, COLORADO

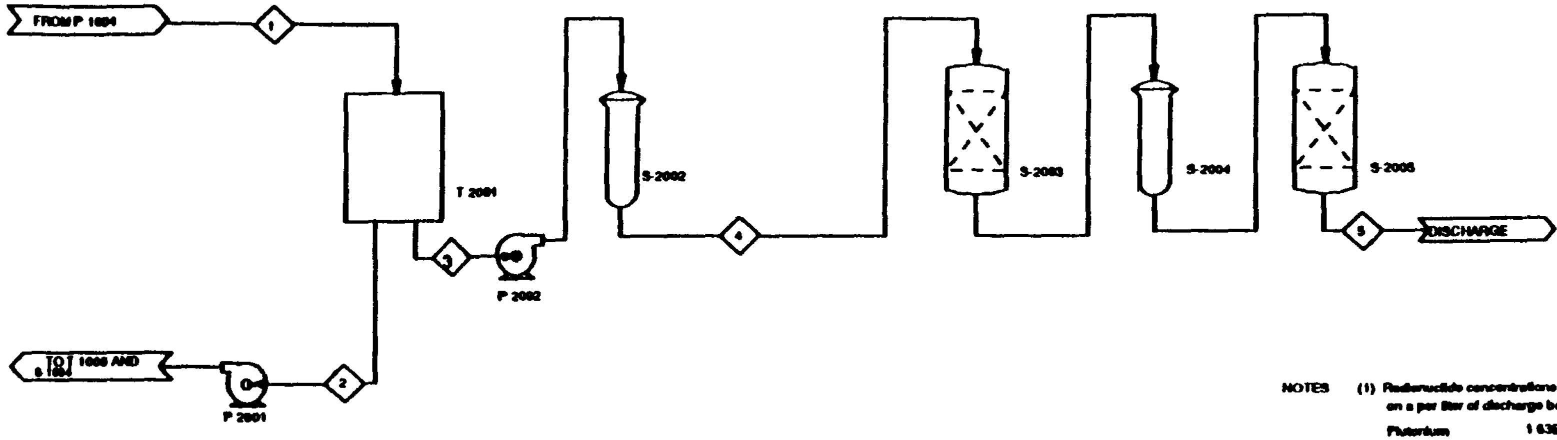
SOLIDS REMOVAL BY SAND FILTRATION WITH BACKWASH TO CLARIFICATION

FOR INFORMATION ONLY

ALTERNATIVE 6
PROCESS FLOW DIAGRAM
CONDITIONING

ALTEC DRW

DATE		JOB NUMBER	DWG No	304919 B5A	REV 0
SCALE	NONE	304919			



NOTES (1) Radionuclide concentrations in Stream 5 on a per liter of discharge basis

Plutonium	1 63E-5 pCi/l
Americium	1 12E 5 pCi/l
Gross Beta	1 74E-3 pCi/l
Uranium	0 0112 pCi/l
Gross Alpha	0 0112 pCi/l

S-2002 CARTRIDGE FILTERS

S-2004 BAG FILTERS

S-2003 CARBON ADSORBER

T 2001 BACKWASH WATER TANK

S-2005 ION EXCHANGE

P-2002 BOOSTER PUMP

P 2001 BACKWASH TRANSFER PUMP

STREAM NUMBER		1	2	3	4	5	6	7	8	9	10	11	12	13		
COMPONENT		POLISH INFLUENT	BCKWASH WATER	CART INFLUENT	CART EFFLUENT	DISCH										
MASS FLOW (WATER) LB/MIN		12526	400	12057	12057	12057										
MASS FLOW (SOLIDS) LB/MIN		0 0101	3 70E 4	0 00072	6 20E 4	3 10E 4										
TEMPERATURE		AMB	AMB	AMB	AMB	AMB										
SUSP SOLIDS DENSITY	LB/FT3	67 0	67 0	67 0	67 0	67 0										
LIQUID DENSITY	LB/FT3	62 4	62 4	62 4	62 4	62 4										
pH		7 10	7 10	7 10	7 10	7 10										
TDS	LB/MIN	1 75	0 0056	1 60	1 60	1 60										
PLUTONIUM	pCi/MIN	2 0	0 110	2 70	0 170	0 0800										
AMERICIUM	pCi/MIN	2 0	0 0740	1 92	0 123	0 0615										
GROSS BETA	pCi/MIN	310	11 6	200	10 1	9 56										
URANIUM	pCi/MIN	63000	2300	61200	61200	61 2										
GROSS ALPHA	pCi/MIN	63000	2300	61200	61200	61 2										
ATRAZINE	LB/MIN	1 4E-4	5 34E 6	1 30E 4	1 30E 4	6 00E 5										
SIMAZINE	LB/MIN	2 4E 5	8 00E 7	2 31E 5	2 31E 5	6 00E 5										

IT CORPORATION

ROCKY FLATS PLANT
GOLDEN, COLORADO

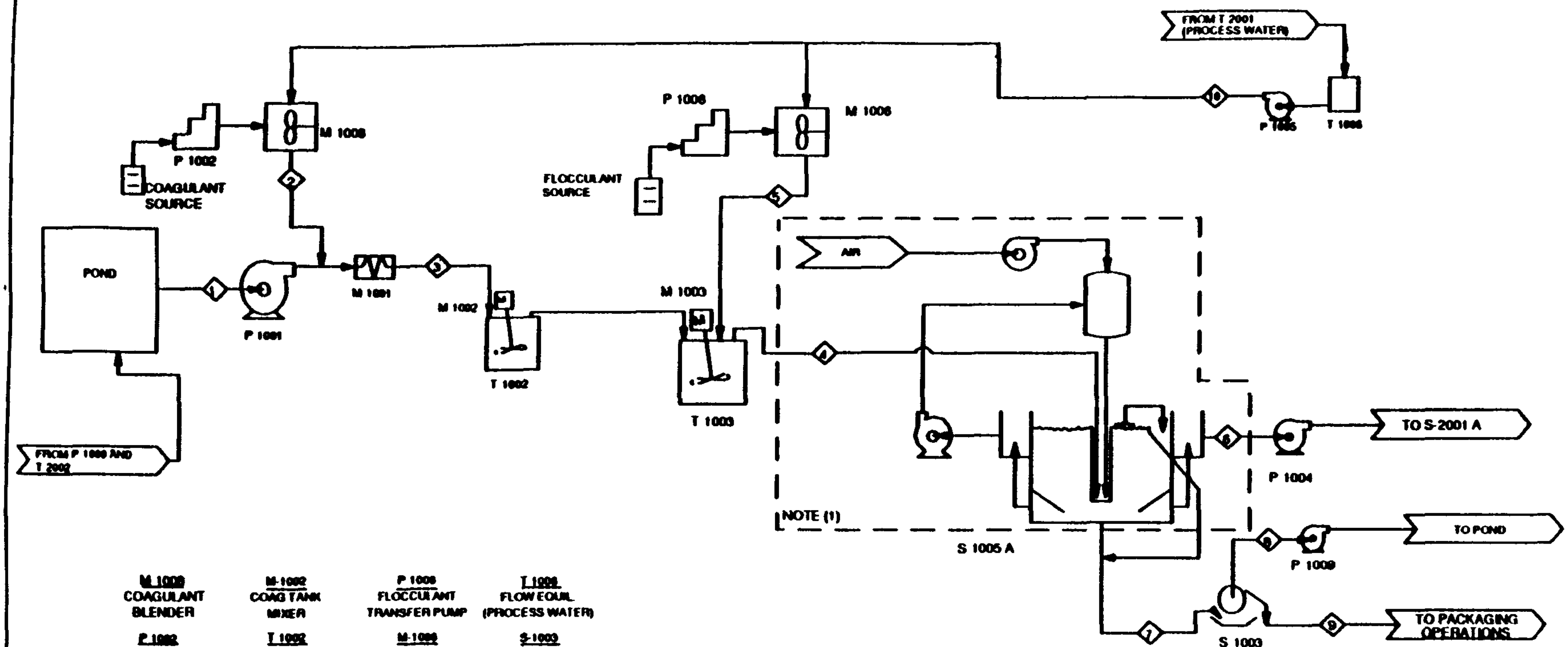
EFFLUENT POLISHING BY
FILTRATION, CARBON ADSORPTION & ION EXCHANGE

FOR INFORMATION ONLY

ALTERNATIVE 6
PROCESS FLOW DIAGRAM
POLISHING

DATE		JOB NUMBER	DWG No	304919 B5B	REV
SCALE	NONE	304919			0

ALTSP DRW



M 1000 COAGULANT BLENDER
P 1002 COAG TRANSFER PUMP
P 1001 POND WATER TRANSFER PUMP
M 1001 STATIC MIXER (COAG)

M 1002 COAG TANK MIXER
T 1002 COAGULATION TANK
M 1003 FLOCCULATION TANK MIXER
T 1003 FLOCCULATION TANK

P 1006 FLOCCULANT TRANSFER PUMP
M 1006 FLOCCULANT BLENDER
P 1004 EFFLUENT TRANSFER PUMP
S 1005 A DAF PACKAGE

T 1006 FLOW EQUIL (PROCESS WATER)
S 1003 FILTER PRESS
P 1005 PROCESS WATER PUMP
P 1009 RECYCLE PUMP PRESS EFFLUENT

NOTES

(1) DAF system is supplied a packaged unit

(2) Contribution of these parameters by process water is negligible

(3) Radionuclide concentrations in Stream 9 on a per gram of sludge basis (30% solids)

Plutonium	0 200	pCi/g
Americium	0 130	pCi/g
Gross Beta	21 4	pCi/g
Uranium	0 00762	pCi/g
Gross Alpha	0 00762	pCi/g

STREAM NUMBER		1	2	3	4	5	6	7	8	9	10
COMPONENT		POND WATER	COAG SOLUTN	COAG SLURRY	FLOC SLURRY	FLOC SOLUTN	DAF EFFLUENT	DAF SLUDGE	PRESS EFFLUENT	PRESS CAKE	PROCESS WATER
MASS FLOW (WATER) LB/MIN		12512	14 20	12526	12528	1 24	12485	42 7	38 6	4 14	16
MASS FLOW (SOLIDS) LB/MIN		1 25	0	2 82	2 83	0	0 100	1 93	0	1 93	NOTE (2)
TEMPERATURE		AMB	AMB	AMB	AMB	AMB	AMB	AMB	AMB	AMB	
SUSP SOLIDS DENSITY	LB/FT3	62 4	N/A	67 0	67 0	N/A	67 0	67 0	67 0	67 0	
LIQUID DENSITY	LB/FT3	62 4	62 4	62 4	62 4	62 4	62 4	62 4	62 4	62 4	
pH		7 10		7 10	7 10		7 10	7 10	7 10	7 10	
TDS	LB/MIN	1 75	0 752	1 75	1 75	0 0125	1 74	0 00596	0 00530	0 000570	
PLUTONIUM	pCi/MIN	500	0	500	500	0	29 0	551	0	551	
AMERICIUM	pCi/MIN	400	0	400	400	0	20 0	380	0	380	
GROSS BETA	pCi/MIN	62000	0	62000	62000	0	3100	58900	0	58900	
URANIUM	pCi/MIN	63600	0	63600	63600	0	63400	217	196	21 0	
GROSS ALPHA	pCi/MIN	63600	0	63600	63600	0	63400	217	196	21 0	
ATRAZINE	LB/MIN	1 4E 4	0	1 4E 4	1 4E 4	0	1 4E 4	4 77E 7	4 31E 7	4 62E 8	
SIMAZINE	LB/MIN	2 4E 5	0	2 4E 5	2 4E 5	0	2 4E 5	8 14E 8	7 30E 8	7 83E 9	

IT CORPORATION

ROCKY FLATS PLANT
GOLDEN COLORADO

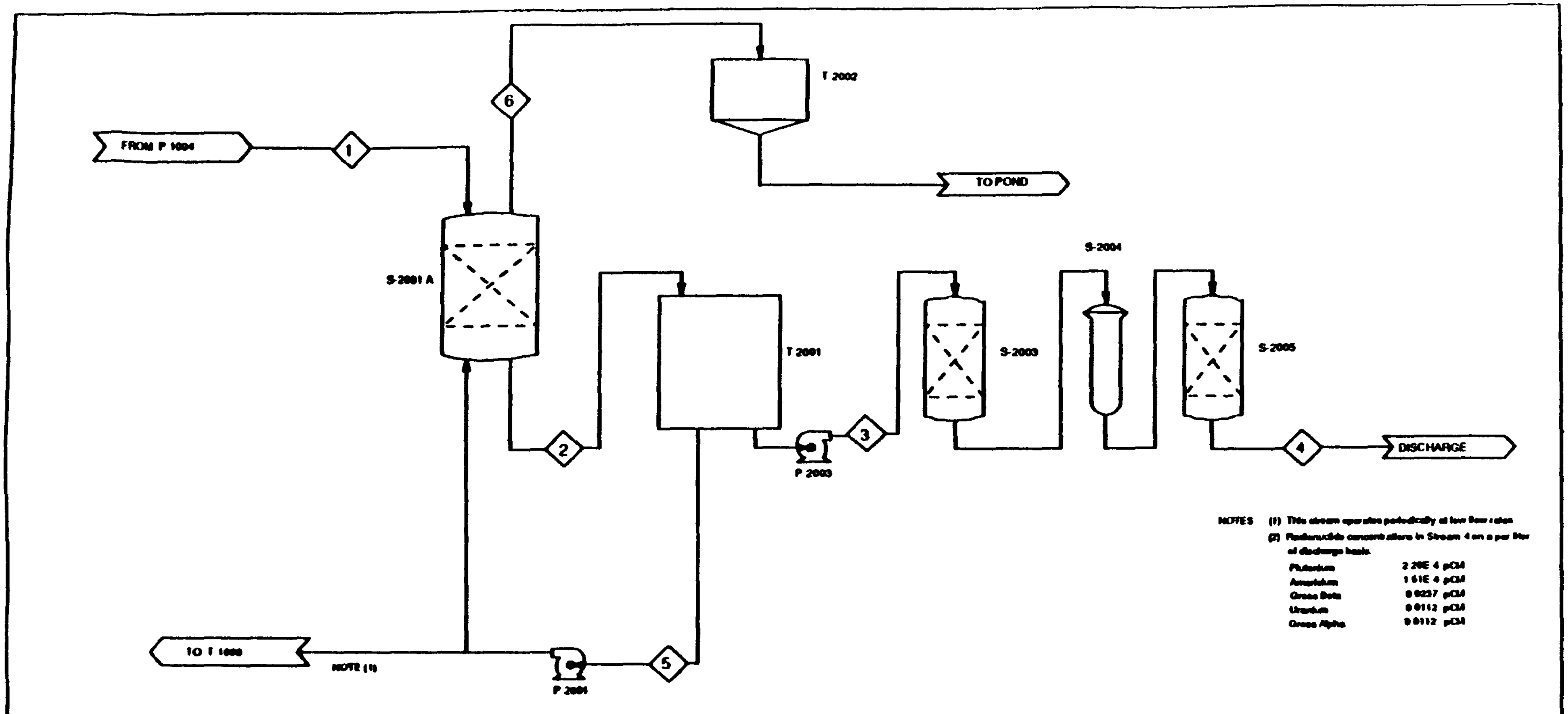
SOLIDS REMOVAL BY DISSOLVED AIR FLOTATION

FOR INFORMATION ONLY

ALTERNATIVE 7
PROCESS FLOW DIAGRAM
CONDITIONING

AL 7C DRW

DATE		JOB NUMBER	DWG No	REV
SCALE	NONE	304919	304919 B7A	0



NOTES (1) This stream operates periodically at low flow rates
(2) Radionuclide concentrations in Stream 4 on a per liter of discharge basis.

Plutonium	2 20E 4 pCi/l
Americium	1 61E 4 pCi/l
Gross Beta	0 0237 pCi/l
Uranium	0 0112 pCi/l
Gross Alpha	0 0112 pCi/l

S-2001 A SAND FILTER — P-2001 BACKWASH TRANSFER PUMP — S-2003 CARBON ADSORBER — T-2001 FLOW EQUIL. TANK — T-2002 FLOW EQUILIZATION TANK — S-2004 BAG FILTERS — P-2003 BOOSTER PUMP — S-2005 ION EXCHANGE

STREAM NUMBER		1	2	3	4	5	6
COMPONENT		POLISH. INFLUENT	S. FILTER EFFLUENT	CARB INFLUENT	DISCH	BACKWASH WATER	BACKWASH EFFLUENT
MASS FLOW (WATER) LB/MIN		12495	12495	12000	12000	474	474
MASS FLOW (SOLIDS) LB/MIN		0 160	0 0686	0 00827	0 00414	3 27E 4	0 0917
TEMPERATURE		AMB	AMB	AMB	AMB	AMB	AMB
SUSP. SOLIDS DENSITY	LB/FT3	67 8	67 8	67 8	67 8	67 8	67 8
LIQUID DENSITY	LB/FT3	62 4	62 4	62 4	62 4	62 4	62 4
pH		7 10	7 10	7 10	7 10	7 10	7 10
TDS	LB/MIN	1 74	1 74	1 67	1 67	0 0651	0 0651
PLUTONIUM	pCi/MIN	20 0	2 40	2 40	1 20	0 0048	26 6
AMERICIUM	pCi/MIN	20 0	1 72	1 66	0 835	0 0054	18 3
GROSS BETA	pCi/MIN	3100	287	287	120	10 1	2840
URANIUM	pCi/MIN	63400	63400	61000	61 0	2400	2400
GROSS ALPHA	pCi/MIN	63400	63400	61000	61 0	2400	2400
ATRAZINE	LB/MIN	1 4E 4	1 4E 4	1 39E 4	6 00E 6	5 32E 6	5 32E 6
SIMAZINE	LB/MIN	2 4E 6	2 4E 6	2 30E 6	6 00E 8	9 06E 7	9 06E 7

IT CORPORATION

ROCKY FLATS PLANT
GOLDEN, COLORADO

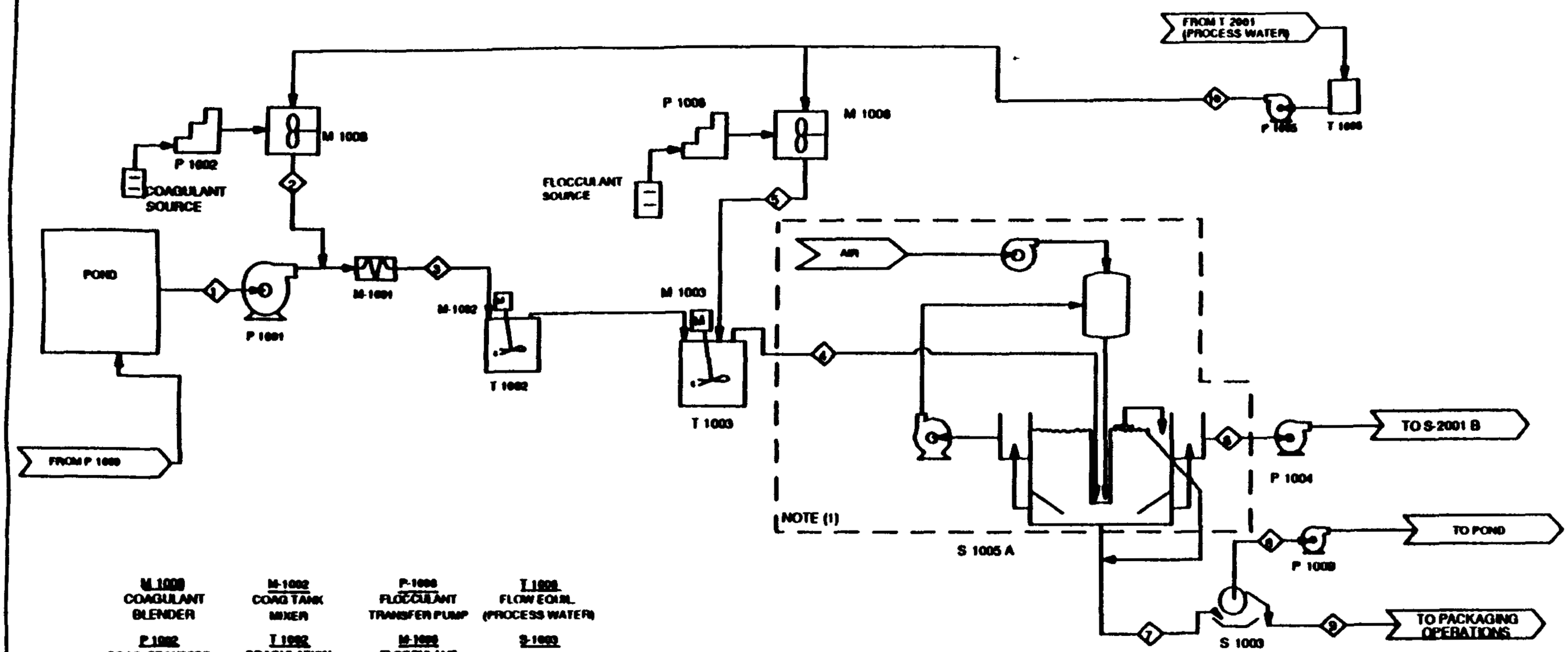
EFFLUENT POLISHING BY FILTRATION, CARBON ADSORPTION & ION EXCHANGE

FOR INFORMATION ONLY

ALTERNATIVE 7
PROCESS FLOW DIAGRAM
POLISHING

ALT7P DRW

DATE		JOB NUMBER	DWG No	304919 B78	REV 0
SCALE	NONE	304919			



M 1008 COAGULANT BLENDER

P 1002 COAG TRANSFER PUMP

P 1001 POND WATER TRANSFER PUMP

M 1001 STATIC MIXER (COAG)

M-1002 COAG TANK MIXER

T 1002 COAGULATION TANK

M-1003 FLOCCULATION TANK MIXER

T 1003 FLOCCULATION TANK

P-1006 FLOCCULANT TRANSFER PUMP

M-1006 FLOCCULANT BLENDER

P-1004 EFFLUENT TRANSFER PUMP

S-1005 A DAF PACKAGE

T 1005 FLOW EQUIL. (PROCESS WATER)

S-1003 FILTER PRESS

P 1005 PROCESS WATER PUMP

P 1009 RECYCLE PUMP PRESS EFFLUENT

NOTES

(1) DAF system to be supplied as a packaged unit.

(2) Contribution of these parameters by process water is negligible.

(3) Radionuclide concentrations in Stream 9 on a per gram of sludge basis (30% solids)

Plutonium	—	0 200	pCi/g
Americium		0 130	pCi/g
Gross Beta	—	21 4	pCi/g
Uranium		0 00782	pCi/g
Gross Alpha		0 00782	pCi/g

STREAM NUMBER		1	2	3	4	5	6	7	8	9	10					
COMPONENT		POND WATER	COAG SOLUTN	COAG SLURRY	FLOC SLURRY	FLOC SOLUTN	DAF EFFLUENT	DAF SLUDGE	PRESS EFFLUENT	PRESS CAKE	PROCESS WATER					
MASS FLOW (WATER) LB/MIN		12512	14 28	12526	12528	1 24	12485	42 7	38 6	4 14	16					
MASS FLOW (SOLIDS) LB/MIN		1 25	0	2 02	2 03	0	0 100	1 93	0	1 93	NOTE (2)					
TEMPERATURE		AMB	AMB	AMB	AMB	AMB	AMB	AMB	AMB	AMB						
SUSP SOLIDS DENSITY	LB/FT3	62 4	N/A	67 8	67 8	N/A	67 8	67 8	67 8	67 8						
LIQUID DENSITY	LB/FT3	62 4	62 4	62 4	62 4	62 4	62 4	62 4	62 4	62 4						
pH		7 10		7 10	7 10		7 10	7 10	7 10	7 10						
TDS	LB/MIN	1 75	0 752	1 75	1 75	0 0125	1 74	0 00596	0 00538	0 000578						
PLUTONIUM	pCi/MIN	580	0	580	580	0	29 0	551	0	551						
AMERICIUM	pCi/MIN	400	0	400	400	0	20 0	380	0	380						
GROSS BETA	pCi/MIN	67000	0	67000	67000	0	3100	50000	0	50000						
URANIUM	pCi/MIN	[illegible]	0	[illegible]	[illegible]	0	[illegible]	217	196	21 0						
GROSS ALPHA	pCi/MIN	[illegible]	0	[illegible]	[illegible]	0	[illegible]	217	196	21 0						
[illegible]	LB/MIN	[illegible]	0	[illegible]	[illegible]	0	[illegible]	[illegible]	[illegible]	[illegible]						
[illegible]	LB/MIN	[illegible]	0	[illegible]	[illegible]	0	[illegible]	[illegible]	[illegible]	[illegible]						

IT CORPORATION

ROCKY FLATS PLANT
GOLDEN, COLORADO

SOLIDS REMOVAL BY DISSOLVED AIR FLOTATION

FOR INFORMATION ONLY

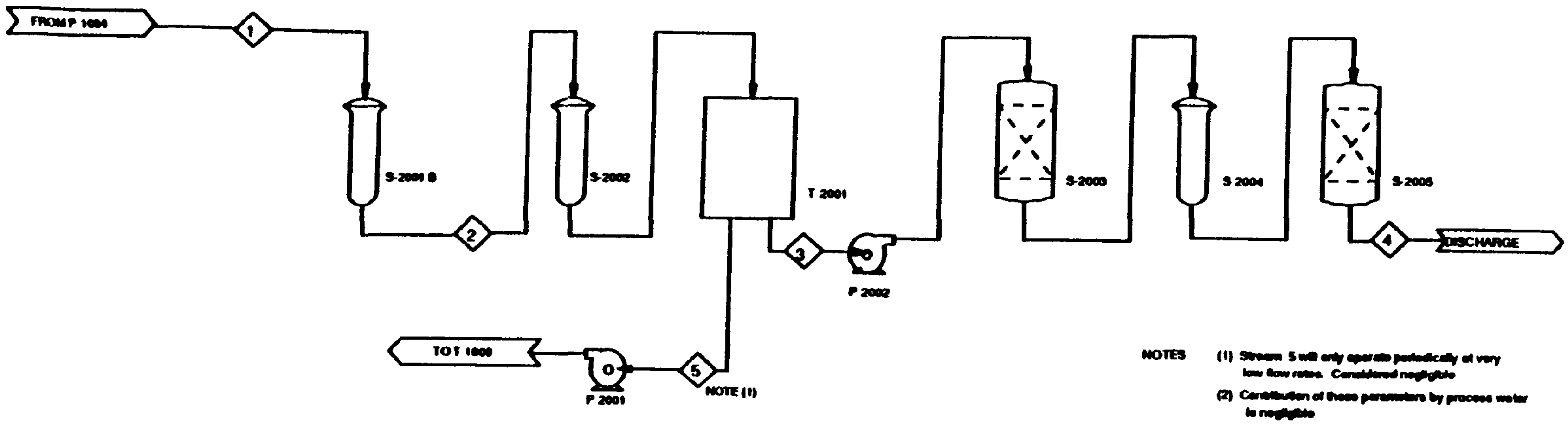
ALTERNATIVE 8

PROCESS FLOW DIAGRAM

CONDITIONING

ALTEC DRW

DATE		JOB NUMBER	DWG No	REV
SCALE	NONE	304919	304919 B8A	0



S-2002 CARTRIDGE FILTERS

S-2001 B BAG FILTERS

S-2003 CARBON ADSORBER

S-2004 BAG FILTERS

S-2005 ION EXCHANGE

T-2001 FLOW EQUIL. TANK

P 2001 PROCESS WATER TRANSFER PUMP

P-2002 BOOSTER PUMP

NOTES

(1) Stream 5 will only operate periodically at very low flow rates. Considered negligible

(2) Contribution of these parameters by process water is negligible

(3) Radionuclide concentrations in Stream 5 on a per liter of discharge basis

Plutonium	2.56E-6	pCi/l
Americium	1.70E-6	pCi/l
Gross Beta	2.74E-3	pCi/l
Uranium	0.0112	pCi/l
Gross Alpha	0.0112	pCi/l

STREAM NUMBER		1	2	3	4	5										
COMPONENT		POLISH. INFLUENT	CARF INFLUENT	CARX INFLUENT	DISCH	PROCESS WATER										
MASS FLOW (WATER) LB/MIN		12465	12465	12465	12465	16										
MASS FLOW (SOLIDS) LB/MIN		0.100	0.0830	0.00168	5.19E-4	NOTE(2)										
TEMPERATURE		AMB	AMB	AMB	AMB											
SUSP. SOLIDS DENSITY	LB/FT3	67.8	67.8	67.8	67.8											
LIQUID DENSITY	LB/FT3	62.4	62.4	62.4	62.4											
pH		7.10	7.10	7.10	7.10											
TDS	LB/MIN	1.70	1.70	1.70	1.70											
PLUTONIUM	pCi/MIN	20.0	6.90	0.200	0.145											
AMERICIUM	pCi/MIN	20.0	4.70	0.200	0.100											
GROSS BETA	pCi/MIN	3400	730	34.0	15.5											
URANIUM	pCi/MIN	63400	63400	63400	63.4											
GROSS ALPHA	pCi/MIN	63400	63400	63400	63.4											
ATRAZINE	LB/MIN	1.4E-4	1.4E-4	1.4E-4	6.24E-6											
SIMAZINE	LB/MIN	2.4E-5	2.4E-5	2.4E-5	6.24E-6											

IT CORPORATION

ROCKY FLATS PLANT
GOLDEN, COLORADO

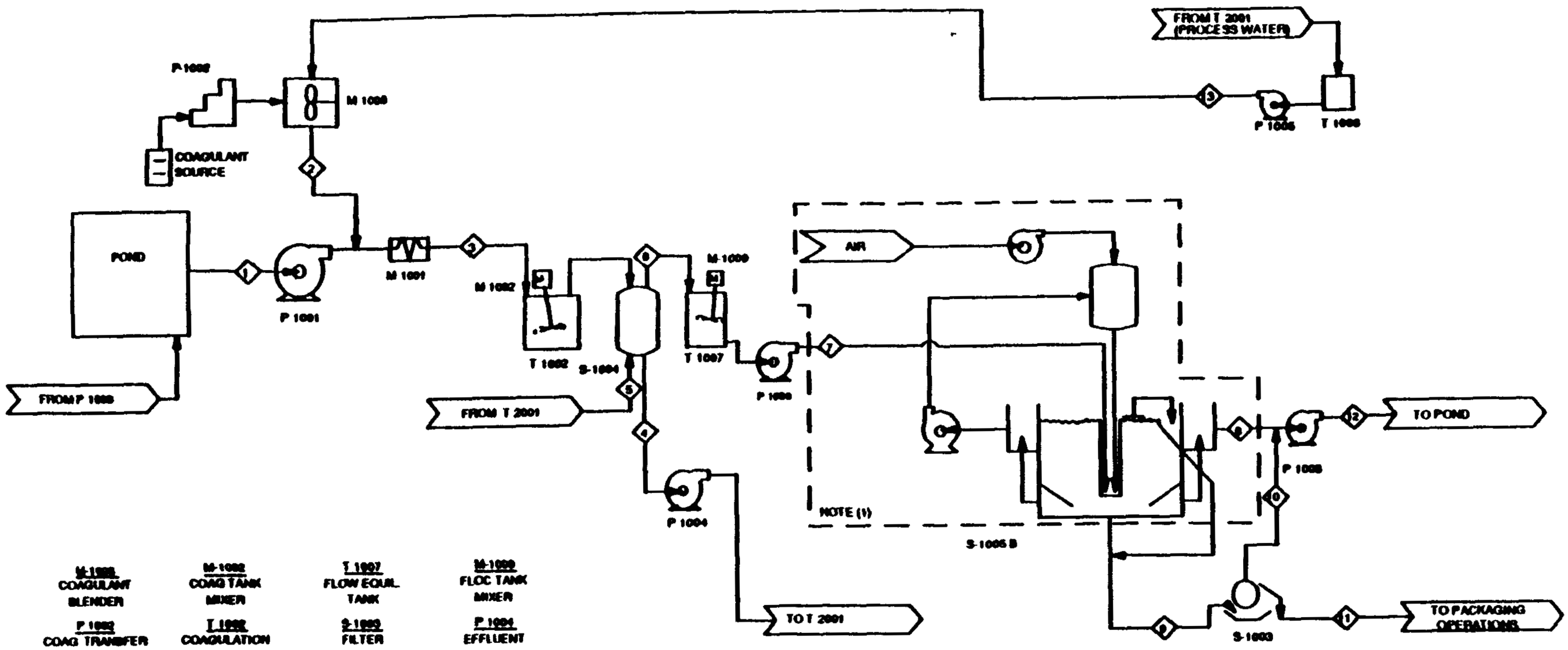
EFFLUENT POLISHING BY
FILTRATION, CARBON ADSORPTION & ION EXCHANGE

FOR INFORMATION ONLY

ALTERNATIVE 8
PROCESS FLOW DIAGRAM
POLISHING

ALT 8P DRW

DATE		JOB NUMBER	DWG No	REV
SCALE	NONE	304919	304919 B8B	0



M-1000 COAGULANT BLENDER

P 1002 COAG TRANSFER PUMP

P 1001 POND WATER TRANSFER PUMP

M-1001 STATIC MIXER (COAG)

M-1002 COAG TANK MIXER

T 1002 COAGULATION TANK

P 1003 SLUDGE TRANSFER PUMP

S-1005 B DAF PACKAGE

T 1007 FLOW EQUIL TANK

S-1003 FILTER PRESS

S-1004 SAND FILTER

P-1009 RECYCLE PUMP

M-1009 FLOC TANK MIXER

P 1004 EFFLUENT TRAN PUMP

T 1008 FLOW EQUIL (PROCESS WATER)

P 1006 PROCESS WATER PUMP

NOTES

(1) DAF System to be supplied as packaged unit.

(2) Contribution to these parameters by process water is negligible.

(3) Radionuclide concentrations in Stream 11 on a per gram of sludge basis (30% solids):

Plutonium	---	0.204	pCi/g
Americium	---	0.130	pCi/g
Gross Beta	---	21.6	pCi/g
Uranium	---	0.00702	pCi/g
Gross Alpha	---	0.00702	pCi/g

STREAM NUMBER		1	2	3	4	5	6	7	8	9	10	11	12	13		
COMPONENT		POND WATER	COAG SOLUT'N	COAG SLURRY	S FILTER EFFLUENT	BACKWASH WATER	BACKWASH EFFLUENT	DAF INFLUENT	DAF EFFLUENT	DAF SLUDGE	PRESS EFFLUENT	PRESS CAKE	RECYCLE	PROCESS WATER		
MASS FLOW (WATER)	LB/MIN	12512	14.20	12526	12526	469	469	469	427	42.2	30.1	4.10	465	16		
MASS FLOW (SOLIDS)	LB/MIN	1.25	0	2.02	0.0101	3.70E-4	2.01	2.01	0.100	1.91	0	1.91	0.100	NOTE (2)		
TEMPERATURE		AMB	AMB	AMB	AMB	AMB	AMB	AMB	AMB	AMB	AMB	AMB	AMB			
SUSP. SOLIDS DENSITY	LB/FT3	62.4	N/A	67.8	67.8	67.8	67.8	67.8	67.8	67.8	N/A	67.8	67.8			
LIQUID DENSITY	LB/FT3	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4	62.4			
pH		7.10		7.10	7.10	7.10	7.10	7.10	7.10	7.10	7.10	7.10	7.10			
TDS	LB/MIN	1.75	0.752	1.75	1.75	0.0656	0.0656	0.0656	0.0597	0.0060	0.00513	6.71E-4	0.0660			
PLUTONIUM	pCi/MIN	500	0	500	2.0	0.110	577	577	29.0	640	0	640	29.0			
AMERICIUM	pCi/MIN	400	0	400	2.0	0.0740	390	390	29.0	370	0	370	29.0			
GROSS BETA	pCi/MIN	62000	0	62000	310	11.6	61700	61700	3100	66600	0	66600	3100			
URANIUM	pCi/MIN	63000	0	63600	63600	2300	2300	2300	2170	214	193	20.0	2303			
GROSS ALPHA	pCi/MIN	63600	0	63600	63600	2300	2300	2300	2170	214	193	20.0	2303			
ATRAZINE	LB/MIN	1.4E-4	0	1.4E-4	1.4E-4	5.24E-6	5.24E-6	5.24E-6	4.76E-6	4.73E-7	4.27E-7	4.60E-8	5.21E-6			
SIMAZINE	LB/MIN	2.4E-5	0	2.4E-5	2.4E-5	8.00E-7	8.00E-7	8.00E-7	8.10E-7	8.00E-8	7.30E-8	7.06E-9	8.01E-7			

IT CORPORATION

ROCKY FLATS PLANT
GOLDEN, COLORADO

SOLIDS REMOVAL BY SAND FILTRATION PRIOR TO DISSOLVED AIR FLOTATION

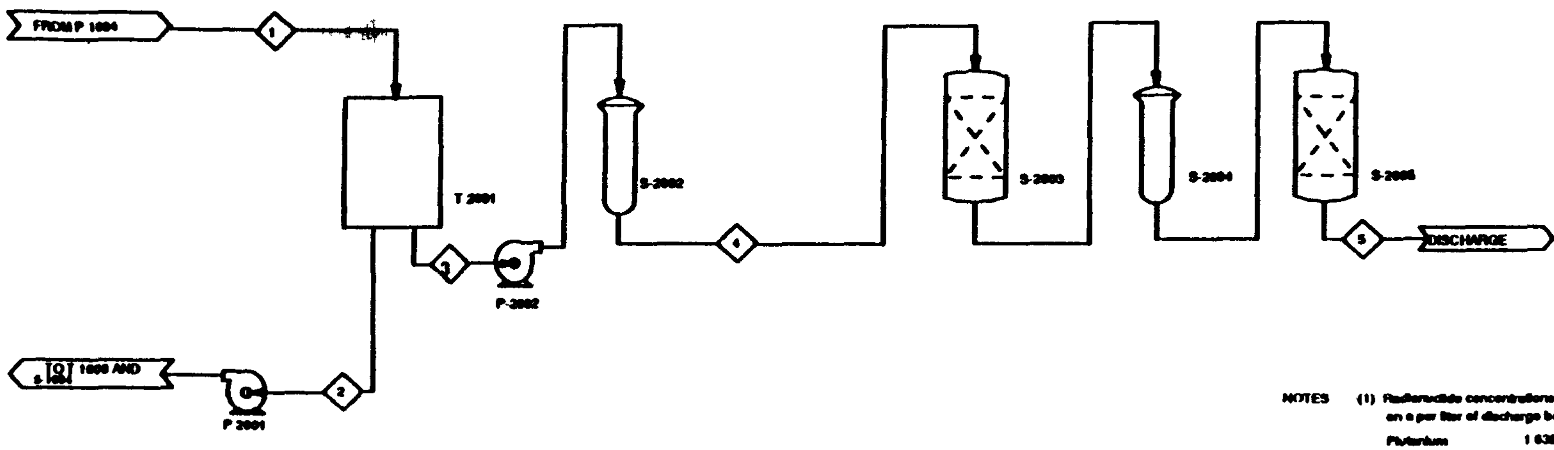
FOR INFORMATION ONLY

ALTERNATIVE 11

PROCESS FLOW DIAGRAM
CONDITIONING

ALT11C DRW

DATE		JOB NUMBER	DWG No	REV
SCALE	NONE	304919	304919 B11A	0



NOTES (1) Radionuclide concentrations in Stream 5 on a per liter of discharge basis

Plutonium	1 63E-5 pCi/l
Americium	1 12E 5 pCi/l
Gross Beta	1 74E 3 pCi/l
Uranium	0 0112 pCi/l
Gross Alpha	0 0112 pCi/l

S-2002 CARTRIDGE FILTERS

S-2004 BAG FILTERS

S-2003 CARBON ADSORBER

T 2001 BACKWASH WATER TANK

S-2005 ION EXCHANGE

P-2002 BOOSTER PUMP

P 2001 BACKWASH TRANSFER PUMP

STREAM NUMBER		1	2	3	4	5	6	7	8	9	10	11	12	13		
COMPONENT		POLISH INFLUENT	BCKWASH WATER	CARB INFLUENT	CARB EFFLUENT	DISCH										
MASS FLOW (WATER) LB/MIN		12526	400	12057	12057	12057										
MASS FLOW (SOLIDS) LB/MIN		0 0101	3 70E 4	0 00072	6 20E 4	3 10E 4										
TEMPERATURE		AMB	AMB	AMB	AMB	AMB										
SUSP SOLIDS DENSITY	LB/FT3	67 8	67 8	67 8	67 8	67 8										
LIQUID DENSITY	LB/FT3	62 4	62 4	62 4	62 4	62 4										
pH		7 10	7 10	7 10	7 10	7 10										
TDS	LB/MIN	1 75	0 0560	1 60	1 60	1 60										
PLUTONIUM	pCi/MIN	2 0	0 110	2 70	0 170	0 0900										
AMERICIUM	pCi/MIN	2 0	0 0700	1 02	0 123	0 0615										
GROSS BETA	pCi/MIN	310	11 6	200	10 1	9 56										
URANIUM	pCi/MIN	63000	2300	61200	61200	61 2										
GROSS ALPHA	pCi/MIN	63000	2300	61200	61200	61 2										
ATRAZINE	LB/MIN	1 4E 4	5 24E 6	1 30E 4	1 30E 4	6 60E 5										
SIMAZINE	LB/MIN	2 4E 6	8 90E 7	2 31E 5	2 31E 5	6 60E 5										

IT CORPORATION

ROCKY FLATS PLANT
GOLDEN, COLORADO

EFFLUENT POLISHING BY
FILTRATION CARBON ADSORPTION & ION EXCHANGE

FOR INFORMATION ONLY

ALTERNATIVE 11
PROCESS FLOW DIAGRAM
POLISHING

DATE		JOB NUMBER	DWG No		REV
SCALE	NONE	304919		304919 B11E	0

ALT11P DRW